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STIMULUS FROM RURAL JAPAN.

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No wa kuni no taikon nari (Agriculture is the basis of a nation.)

THE basic fact about Japan, the majority of the population of which is agricultural, explains a lot of things. That basic fact is that a large part of the country is uninhabitable. There are two dozen mountains from twice to thrice the height of Ben Nevis, about fifty more or less active volcanoes, and 46 million acres of forest. The habitable area (according to the Imperial Bureau of Statistics) is only 19 per cent., compared with 74 per cent. for Belgium and 70 for France. The average area of the holdings of the 5½ million farming families is therefore very small—three acres. Japan is as big as England and Scotland, plus an area four times the size of Wales, but there are several millions more people in Japan than there are in Great Britain.

It is not only because the Japanese are accustomed to rice in the place in their dietary which bread occupies in ours—good rice has something of the property of oatmeal, the property of a continual tastiness—and because the Japanese climate is favourable to the cultivation of rice that more than half the cultivated area is given to it. Much labour is spent on rice because of its high yield. It may be at the rate of 50, 60 or 70, or even 80 bushels an acre.

I have seen more than one rice field no bigger than a hearthrug. Agricultural experts, when they discuss the question of the ideal size for a rice field, do not let their notions soar beyond a quarter of an acre or at most an acre.

The laboriousness of rice culture is almost past the Western farmer's belief. Rice is a reed. Ordinarily it must be planted out in water, and this water must be kept at a uniform depth. (I say ordinarily, because there is a land rice which is grown out of water and covers an area almost equal to that of the paddies on which the rice we know most about is cultivated; but the price obtained for upland rice is only about half that got for paddy rice). Because of the water needs of rice, a ricefield must be level and if possible watertight; it must have low mud walls round it, built afresh each season (for beans are grown on them), and

a system of irrigation must be arranged to make good the loss of water by evaporation, by leakage, and by the continual passing on of some of the water to other plots belonging to the same owner or to other farmers. As a usual thing, rice fields are of all shapes, and are here, there and everywhere. This is because when ricefields are made farmers are restricted by soil conditions, by their financial resources, and by the position and water needs of neighbours' rice fields.

But there arose wise men to point out that for a farmer to work a number of oddly-shaped bits of land, scattered throughout other people's holdings, was uneconomical. So what was called an adjustment of rice fields was carried out in many places. The farmers were persuaded to throw their assortments of fields into hotchpot, and to have the mass cut up into oblong fields of equal or relative sizes, to be shared according to what each man had contributed in quantity and quality. The farmers were then able to devote their time to working their rice fields instead of walking to and from them. The abolition of unnecessary paths and divisions added to the quantity of land to be cropped, it was possible to use an ox or pony in cultivation, and the water supply problem was easier. (A quarter of the water used for paddies comes from specially made reservoirs and no small proportion of the water brought from the reservoirs, rivers and lakes is conducted through tunnels cut many years ago). The average increase in yield after adjustment is estimated at 15 per cent. About nine and a half million pounds—and, until a year or two ago, a pound went a long way in labour in rural Japan—has been spent or is about to be spent in the work of adjustment.

This adjustment is a joy to the rural sociologist, for what a triumph over conservatism it is! It was not only the cutting up of land to which there was the ordinary attachment of a farmer to his own holding—half of the cultivated land is owned by those who work it. According to geomantic notions some of the land to be given up was specially "fortunate." Further, the readjustment often meant the pulling down of cottages and the removal of graves—rural Japan buries its dead on its own land. In a village in which there had been an exhumation of the bones of 2700 persons and a transference of tombstones, I was told that the assembling together of the remains of the departed had had "a unifying effect on the community."

One of the advantages of adjustment is that the adjusted paddies can usually be dried off at harvest and put under another crop. Otherwise, harvesting (as well as ploughing, harrowing, manuring, planting-out and weeding) must all be done in sludge, as often as not infested by leeches. The crop is dried on temporary fences or racks, rigged up in the paddy or along paths or by the roadside. On rainy days rice field-workers wear the well-known wide straw hats and loose straw mantles, admirable in their combination of lightness and waterproofness. To go back to the planting of rice, the seed beds from which the rice is transplanted

to the paddies in spring are under water like the paddies themselves. These seed beds are frequently a communal enterprise, and school children are given holidays to catch insects which assail the young plants, and to pull out the weeds. In many localities specially fine varieties are grown for seed on the land of the Shinto shrines. In fifteen years the average yield of the rice fields of the country has risen 2½ bushels per quarter acre.

It has been said that the farmers spend a quarter of their incomes on chemical manures. But the most important manurial agent is still human excreta, brought many miles in tubs on lorries, as often drawn (or pushed) by men and women as by horses, and carefully preserved in the fields in well-covered sunken hogsheads or in concrete tanks. (One city receives £7,000 a year for its manure from a rural co-operative society.) Compost is another valuable standby. It must be remembered that the Japanese countryside is usually bare of stock. The annual value of the compost has been put at 6¼ million pounds, of the human waste at 5½ millions, and of green manure and rice chaff at 1½ millions, as against 3¼ millions for bean cake (applied to the land), 1¼ millions for fish waste, and 6 millions for artificials and miscellaneous.

What one notices in journeying through the rural districts is not only the stench—it follows one everywhere—but also the extraordinary efficiency of the cultivation—in some places weeds are hardly to be seen—and the accessibility of breech-clouted farmers to education. The village school, usually built at considerable financial sacrifices, is often on the best site—there is a larger percentage of illiteracy in the United States than in Japan—and the influence of county, prefectural and national agricultural technical instruction is everywhere apparent. The frugally equipped agricultural schools and colleges—there are 280 upper and lower grade agricultural schools and colleges and 8000 agricultural continuation schools—are conducted with almost a religious devotion, and the care taken over the moral and physical education of students is not less marked than the pains taken to give manual as well as theoretical training in agriculture. Scores of agricultural professors or professors-elect are travelling abroad with official subventions to study the latest methods and ideas in rural technology and sociology. Co-operative societies for the purchase and sale of requirements have made noteworthy strides.

I was struck by the number of wayside memorials to good farmers, to introducers of new crops, and to dead horses; by the way in which the dark evenings were brightened in quite remote villages by electric light, which went into the smallest cottages; and by the aid which is given to rural civilisation by washable cotton clothing and by the daily hot bath. In its simplest form the Japanese bath is a box (about the size of the box in which our grocers receive sides of bacon) with a stove in

it, and an iron chimney running through the water and kept from the bather's knees by a board. As the bather does not enter the bath until he has soaped and washed himself at a small tub, one heating of the water is sufficient for all the members of the family; but there are always public hot baths with a low rate of admission, where the cleanliness which, according to Shinto notions, is next to godliness, is cultivated with few concessions to the prudery which afflicts the Western world.

In every village there is a young men's association, and in very many villages a young women's association. The young men's association, which dates from antiquity, may run an early rising society—members assemble at the shrine and do physical exercises before going to work—may conduct classes or a library; promote economy by encouraging members to wear inexpensive clothes and cut each other's hair; do work in the public service, such as planting waste or ploughing for persons who are ill; urge good cropping, develop secondary industries, arrange excursions to more advanced districts, "respect and comfort" old people, or promote tidiness and decorum—the members of one Y.M.A. "must not remain idling at people's houses." In the diary of a member of a Society for the Cultivation of Rice by Schoolboys, I found the following entry in respect of his quarter acre:—

June	5.	—2 bushels of herring applied.
,,	7.	Locusts and other insects.
,,	20.	153 clumps of rice transplanted.
July	11.	Rice cultivated and 2 bushels of herring applied.
,,	27.	First weeding.
Aug.	6.	—Second weeding.
,,	8.	—Locusts.
,,	11.	Third weeding.
Sept.	10.	—All ears shot.
Oct.	10.	—Some plants suffering from bacillus.

A village I visited was raising a fund by the following system of taxation:-

Birth of a child, 2½d.
Wedding, 3d.
Graduation from the elementary school, 2½d.; higher school, 5d.
Teacher or official on appointment, 2 per cent. of salary; when salary is increased, 10 per cent.
Every villager to pay quarterly ¼d.

It may help a little towards entering the mind of the Japanese countryman if I reproduce the following series of poems from a rural almanac a Japanese poem is in the nature of a sentiment or thought:—

January .	Future of the day determined in the morning
February .	The voice of one reading a farming book coming from the snow-covered window.
March . .	Grafting these young trees, thinking of the days of my grandchildren.
April . .	Digging the soil of the paddy field, sincerity concentrated on the edge of the mattock.

May . . . Returning home with the dim moonlight glinting on the edges of our mattocks.

June . . . Boundless wealth stored up by gracious Heaven: dig it out with your mattock, take it away with your sickle.

July . . . Weeding the paddy field is a happiness and contentment which townspeople do not know. [It is done by wading in leech-infested water under a burning sun, and pulling out the weeds by hand and thrusting them down into the mud.]

August . . Standing peasant worthier than resting rich man.

September . Ears of rice bend their ears as they ripen. [An allusion to wisdom old age and bent backs.]

October . . White steam coming out of a manure house on an autumn morning. [To count the number of manure houses in a village is one of the agricultural expert's methods of guaging its progress. I have in my notebook a sentence in reference to one village: "322 good manure houses."]

November . Moon clear and bright above neatly regulated paddy fields.

December . All the members of the family smiling and celebrating the year's end, piling up many bales of rice.

Now and then one finds a country priest to be a leader in rural progress. One with whom I stayed had for a quarter of a century superintended the education of the young people of his village, been the moving spirit of its co-operative credit and selling society and its poultry society (with 294 members), directed a society for the study of the teaching of a famous social reformer, and had an eye on the young men's association which performed its discipline at the shrine at 5.30 a.m. in the winter and 4 a.m. in the summer. When I asked him for his autograph he wrote, "To rouse the village you must first rouse the priest." When I wished to be told what was the chief obstacle to the further moral improvement of his village he answered, "I am!" A priest I heard speaking at "a conference of skilful farmers," which has been held annually in a certain prefecture for many years, said :—

"I thought it an easy task to make my village good. I began to do good things. I formed several men's and women's associations all at once, as if I were Buddha. But the real condition of the people was not much improved. There came many troubles on me. Then I asked many people to help me. There was a man in the village who was demoralised, and when I told of him to a distinguished man who lives near our village he sympathised very much. That distinguished man is 84 years old, but he accompanied the demoralised man for three days, giving no instruction but simply living the same life, and the demoralised man was an entirely changed man and ever thankful. You skilful farmers kindly come to my village if you pass. You need not give any speech. Your good faces will do. The sight of a good man is enough."

I met a man who had had a monument erected to him. He was formerly the richest man in his village, but, moved by the poverty of his neighbours, he devoted his substance to improving their condition. Now the village has been "praised and rewarded" by the prefecture for its "good farming and good morals," and the philanthropist is a man of small means. Impressed by his unselfishness the village has raised a great slab of stone in his honour.

I visited many agricultural experiment stations. Of one I

have a note that it was visited by 25,000 farmers and students in a year, and that in twelve months it had distributed to agriculturists 7,600 cyanided fruit trees and 80 bushels of a special seed rice.

In several prefectures I heard of the kō, an organisation which is brought into existence among farmers when one of them is in need of financial assistance. A kō is composed of a number of people who agree to subscribe so much apiece monthly and to divide the proceeds monthly by ballot, beginning by giving the first month's receipts to the person to succour whom the kō is formed. Suppose that the subscription were fixed at £1 a month —an impossibly high sum, of course, for Japanese villages—and that there were 50 subscribers, then the beneficiary, who pays in his £1 like every other member, gets £50 at the first ingathering. Every month afterwards the member who is lucky in the ballot gets £50. The monthly paying in and paying out continue for fifty months, and all the subscribers duly get their money back, with the advantage of having had a little excitement and having done a neighbourly action. It is worth noting that many villages have a crematorium on a modest plan. I found the rate at one crematorium to be a shilling for villagers and four shillings for outsiders. There might also be a shilling for the priest.

Some indication of the way in which the leaders of agricultural progress go to work may be gained from the following passage extracted from a publication issued by a landowner to his tenants during the war:—"In the warm, cloudy days insects multiply rapidly. Think of your brothers at the front, struggling against one of the mighty military powers of the world, and be ashamed to be vanquished by insects or by vegetable growth. For the purpose of destroying insects an ample supply of oil is to be had at the experimental farm, as during last year, and payment, therefore, may be deferred until after harvest."

The aspirations of many a Japanese farmer are reflected in the song:—

"Would that my daughter
Were married to a farmer of middle station,
With five acres of farm
And a quarter of an acre in the wood.
No borrowing, no lending,
Both ends meeting.
Visiting the temple by turns
Someone must stay at home.
Going to Heaven sooner or later.
What a happy life!
What a happy life!"

About half the farmers in Japan are tenant farmers. A large number of these tenants are little more than labourers. When I was in Japan there were the beginnings of a tenants' movement. Tenants' strikes were common. This movement has made such progress that there are those who are in a position to understand the agricultural situation who are disposed to think that within

the lifetime of the present generation—it is possible even within twenty years—the present hard-pressed landlord system may come to an end! Wherever the landowners can sell out they are doing so. If the landowning system should actually come to an end within the lifetime of the present generation it would be an extraordinary thing. For it is only fifty years ago that the present landowning system began. At the Restoration the daimyos placed their lands in the hands of the Emperor. These lands were distributed, chiefly to the farmers who worked them, the occupants receiving title-deeds.[1] Already the arrangement, or the later developments of the arrangement, have been found unsatisfactory.

The Japanese Government set itself in 1919 to reclaim from the wild about 625,000 acres of land within nine years. About 40 per cent. of the cost of reclamation is granted to those who undertake the work. (For the regulation of existing rice fields, to which allusion has been made, there is a 15 per cent. grant—7 per cent. from the State and 8 per cent. from the local authorities.) The yearly addition to acreage under tillage in Japan is about 75,000 acres. In order to extend the food supply the Imperial Household, which is a landowner on a great scale, decided in 1918 to sell land, largely forest, of a value of £10,000,000.

If the whole population of Japan be taken at 55 millions, one acre has to feed a little under four persons. The population increases about 600,000 a year, and the annual consumption of rice per head is about five bushels. The production in Japan proper is about 30 million bushels less than the consumption. Rice is imported not only from Oversea Japan (Formosa and Korea), but from Indo-China, Siam, Kwantung and India. The chief products of the Japanese farmer, besides rice and silkworms, are barley, wheat, beans and potatoes (ordinary and sweet). The production of barley and wheat together is about half the production of rice. The moderate amount of meat eating, the abundance of fish, and the use of cotton and silk for clothing, have militated against the development of stock-keeping. The Japanese may be described as vegetarians who eat a little fish. The nitrogenous part of the popular dietary is chiefly obtained from bean products. When I was in Japan there were not five thousand sheep in the whole of the country. About 40 per cent. of the silk of the world (60 per cent. of the American supply) is produced in Japan. Silkworm culture is held to double the income obtainable from ordinary farming. In four years the production of cocoons has increased 12 million bushels. It is a

[1] An eminent Japanese agricultural authority has explained: "The value of the land was obtained by dividing the net yield by the rate of interest. The net yield was the residue of the whole of the product from which the cost of production and the amount of taxes were subtracted. The former was fixed at 15 per cent. of the gross product, and the rate of interest was in most cases 6 per cent. The national land tax was fixed at 3 per cent. and the local tax at 1 per cent. of the value."

peculiarity of Japanese cultivation that no scythe is used, harvesting and mowing being done with the sickle.

DRAINAGE INVESTIGATIONS AT ABERDEEN.

PROFESSOR JAMES HENDRICK.

COMPARATIVELY few drainage investigations have been carried out in this country. Little has been done up to the present except by engineers, who are interested in drainage from the point of view of water supply, and whose records are usually confined to the amount of drainage as compared with the amount of rainfall. Although such figures are of importance to agriculture also, there are many other matters connected with drainage which are even more important, but unfortunately it is more difficult and laborious to obtain exact data with regard to these. From an agricultural point of view, it is more important to ascertain what is removed from the soil in the drainage water, and to the soil investigator a study of the constituents of the drainage is very helpful in throwing light on the complex reactions which take place in the soil.

Drainage investigations can be used to obtain information not merely as to the amount of moisture which percolates through the soil, or is evaporated from it, but also as to the losses of nitrogen and other constituents which the soil suffers through drainage and of the relationship of such losses to the rainfall, the manuring, the crops grown and the nature and composition of the soil. From an immediately practical point of view they are also of use, since they give direct evidence of the rate of loss of manurial materials from the soil and supply facts which assist us in dealing with the vexed problem of the valuation of unexhausted manures.

As the precise and quantitative study of drainage is so important to agriculture from many points of view, it is remarkable that so little has hitherto been done on it in this country. The only agricultural drain gauges which were in existence in Britain, before those at Craibstone were constructed, were those at Rothamsted. Even drainage studies made with small tanks have been rare.

The Craibstone drain gauges are three in number and, like those at Rothamsted, which are also three in number, are each $\frac{1}{1000}$ acre in area. They are composed of undisturbed blocks of soil and sub-soil in their natural condition, enclosed water tight in a construction of thick slate slabs.[1] They are each 40 inches deep, and unlike those at Rothamsted, which are uncropped and unmanured, they are cropped in the same rotation as the

[1] For construction of the drain gauges *see Transactions of Highland Society*, 1921. Vol. xxxiii., pp. 56-79.

surrounding field, and while No. I. is unmanured, No. II. is manured with both dung and artificials, and No. III. is similarly manured and is in addition limed.

Drainage experiments have been made with two kinds of drain gauges (1) those containing blocks of soil undisturbed and in their natural condition. The Craibstone and Rothamsted drain gauges belong to this class. Such drain gauges are difficult and expensive to build and are comparatively rarely used. (2) The other kind of drain gauges consists of tanks large or small which are filled with sub-soil and soil. Such drain gauges can be more cheaply and more easily made, but they cannot accurately represent the conditions which prevail in natural soil. The breaking up of the soil and sub-soil in order to fill them into the tanks necessarily disturbs their natural state of consolidation and also aerates them thoroughly and causes a certain amount of chemical alteration. Such soil would have to settle down for many years before it would even approximately resemble an undisturbed soil. Nevertheless, artificially filled drain gauges can be successfully used for many purposes, and have been extensively used abroad. In many cases, information can be obtained with them more rapidly and economically than with gauges containing blocks of soil in the natural condition.

The soil and climate at Craibstone differ markedly from those at Rothamsted. At Rothamsted, the soil is a heavy loam and composed of thoroughly weathered materials. At Craibstone, as has been shown in previous publications, the soil is a light and friable one, composed of granitic residues which have undergone superficial weathering only.[1]

Craibstone soil is entirely free from carbonate of lime and is slightly acid in reaction. Although the climate at Craibstone differs considerably from that of Rothamsted, there is not a great deal of difference in the annual rainfall. The rainfall in the neighbourhood of Aberdeen averages about 30 inches per annum, which is nearly the same as that at Rothamsted. We have not yet compiled rainfall records at Craibstone over a long enough period to give a reliable average, but, so far as our records go, they indicate that the average rainfall is about 31 or 32 inches per annum.

The drainage water from all the gauges at Craibstone is regularly analysed month by month and not only the nitrogen, but all the other important constituents which it removes from the soil, are determined. The crops grown upon the gauges are also regularly weighed and analysed, as are the manures which are applied to them. A complete record is thus kept of everything which is applied to the gauges and all that is removed from them

[1] "Studies of a Scottish Drift Soil, Part I." By James Hendrick, B.Sc., F.I.C., and William G. Ogg, M.A., B.Sc., (*Jour. of Agr. Science*, Vol. vii., pp. 458–469); "The Value of Mineralogical Examination in Determining Soil Types, with a method of Examination and a Comparison of Certain English and Scottish Soils." By James Hendrick, B.Sc., F.I.C., and George Newlands, M.A., B.Sc., A.I.C., (*Jour. of Agr. Science*, Vol. xiii., pp. 1–16).

in the crop and in the drainage water. Records will have to be kept over a considerable number of years before full value can be obtained from the results. The results obtained vary from year to year with the nature of the season and particularly with the rainfall.

During the four years for which complete records have been obtained it has been found that, roughly speaking, half the rainfall passes through the soil, while half is evaporated again into the atmosphere or transpired through the crop. The proportion which passes through the drain gauges varies with the season. On these cropped drain gauges, in the depth of winter practically as much comes through the soil as falls in rain and snow. As the season advances, the proportion of the rainfall which comes through as drainage diminishes, till, when we reach the summer, all drainage ceases for a longer or shorter period depending on the season. The amount of drainage during the growing period varies with the crop. The bigger the crop, the more water it uses and transpires and, therefore, the less there is to come through in drainage.

The loss of nitrogen from these drain gauges is not nearly so great as that which has been found on the unmanured and uncropped drain gauges at Rothamsted. This is no doubt because a large part both of the nitrate naturally formed in the soil and of that formed from nitrogen compounds added as manure is taken up by the crop. Little more nitrogen comes through the manured gauges than through the unmanured gauge. The nitrogen which comes through is practically all present as nitrate.

The loss of ash constituents differs markedly from that found at Rothamsted, though it may be pointed out that the amount of evidence obtained on this point at Rothamsted is small, as determinations of the ash constituents in the drainage water have not been regularly made. At Craibstone, practically no phosphoric acid appears in the drainage water. In this respect our results are the same as those of Rothamsted. There are great differences, however, in the bases obtained in our drainage water as compared with those recorded elsewhere. The most remarkable result is that on the unmanured gauge, at any rate, the loss of soda is as great as the loss of lime. Such a result has not been recorded anywhere else and it throws an interesting light on the interaction of bases in the soil. In addition to lime and soda, magnesia is also washed through to a considerable extent and markedly more potash appears in our drainage than in that at Rothamsted. Another surprising result is that a great amount of silica appears in the drainage. It is to be remembered that soil of this type is practically free from carbonate of lime, but contains large quantities of compound silicates of potassium, sodium, magnesium and calcium.

At Craibstone the rainfall recorded is taken with an ordinary 5 inch Snowdon rain gauge, which is placed alongside the large drain gauges. At Rothamsted, records are obtained both from a 5 inch rain gauge and from a rain gauge equal in area to the drain

gauges, namely $\frac{1}{1000}$ acre. It is found at Rothamsted that the large rain gauge gives about 10 per cent. more rainfall than the ordinary 5 inch rain gauge. Probably something of the same kind would be found at Craibstone. It is very desirable that a $\frac{1}{1000}$ acre rain gauge should be used there also. At present, this is not being done only because funds are not available for the supply of such an expensive instrument.

In addition to the work of the large drain gauges which enclose the soil in its natural condition, investigations are being carried out with small drainage tanks artificially filled with Craibstone soil. More numerous experiments can be carried out with these than with the large drain gauges and the experiments can be made more rapidly. These small tanks are quite suitable for the determination of many points connected with the drainage.

A number of different investigations are being made upon the Craibstone soil with the aid of such tanks, and what follows is an account of certain experiments which were undertaken to determine (1) how far such a soil was capable of fixing and nitrifying ammonia from sulphate of ammonia, and supplying bases to be washed away in the drainage with the sulphuric and nitric acids produced; (2) how far it can at the same time fix phosphate from the soluble acid manure, superphosphate, and potash from a soluble potassic manure like muriate of potash; (3) what are the bases and acids washed away in the drainage. It is to be remembered that Craibstone soil is free from carbonate of lime and is slightly acid in reaction. It has been frequently stated that carbonate of lime is necessary to the reactions which take place in the soil, and that it is lime derived from carbonate of lime which is chiefly washed away from the soil in combination with the acids removed in the drainage. It was doubtful, also, how far nitrification can take place in a soil free from carbonate of lime and already tending to sourness.

For the purpose of these experiments, four tanks were used each 10 inches in diameter and 20 inches deep. Into each of these, soil and sub-soil from one of the experimental fields at Craibstone were filled in their natural order. A little gravel was placed at the bottom of each tank to facilitate drainage and the bottom of each tank was arranged so that the drainage was drawn off at the lowest point. Of the four tanks, No. I. received no manuring throughout and was the control tank. During the first period No. II. was dressed with sulphate of ammonia at the rate of 5 cwts. per acre, No. III. with superphosphate at the rate of 10 cwts. per acre, and No. IV. with muriate of potash at the rate of 5 cwts. per acre. Distilled water was sprinkled upon the surface of the tanks in such quantity as to represent a heavy rainfall and the drainage was collected over a period of a few weeks. Each tank was given an equal quantity of water and the quantities of drainage obtained from them were almost equal. The drainage waters obtained during the first period were analysed and the results are shown in Table I., stated as pounds per acre. The

amount of material applied in the manure to each tank, stated as pounds per acre, is also shown in the Table.

TABLE I.

DRAINAGE TANK EXPERIMENTS.

Materials Applied and Recovered, stated as Pounds per Acre.
First Period.

TANK	I.	II.		III.		IV.	
	Unmanured	Sulphate of Ammonia		Superphosphate		Muriate of Potash	
	Recovered	Applied	Recovered	Applied	Recovered	Applied	Recovered
Nitrogen as Ammonia	1	119	¾	...	½	...	¾
„ Nitrate	122¼	...	245¾	...	133¼	...	142½
Phosphoric Acid .	1	...	1	160¼	1	...	1
Sulphuric Acid . .	67	339	321	359¾	340¼	1½	109½
Chlorine . . .	41¼	...	42	1	42	273	317
Lime	167	...	415¼	304	301	1	345
Magnesia . . .	41½	...	200½	9¾	89½	1½	84¾
Potash . . .	10¼	...	14	...	10	272	13¼
Soda	102¼	...	136	...	175½	...	152

In the first period no tank received more than one manure, Tank II. being given the nitrogenous manure sulphate of ammonia only, Tank III. the phosphatic manure superphosphate, and Tank IV. the potassic manure muriate of potash. The manures were applied in such quantities as would form a very heavy dressing in practice.

The results obtained, as indicated by the figures in the table, show that the ammonia of sulphate of ammonia is completely fixed by the soil, even when applied in this large quantity, as no more ammonia was washed through in the drainage of No. II. than in the drainage of No. I. On the other hand, all the nitrogen applied as ammonia to No. II. was recovered in the drainage as nitrate. The reaction is almost exactly quantitative, since if we add the amount of nitrogen recovered naturally from the untreated tank No. 1, namely 122¼ lbs., to the nitrogen added as sulphate of ammonia to No. II., namely 119 lbs., the amount is almost the same as that recovered in the drainage of No. II. as nitrate.

The sulphuric acid of the sulphate of ammonia was freely washed through in the drainage, the greater part of what was applied in the manure appearing again in the drainage. At the same time, the bases appearing in the drainage are greatly increased as compared with the unmanured tank, lime and magnesia being both found in the drainage of No. II. in much greater quantity than in the drainage of No. I. Soda, also, was considerably greater in amount in the drainage of No. II., while potash was slightly greater.

The application of superphosphate at the rate of 10 cwts. to the acre to Tank III. did not increase the amount of phosphate found in the drainage. In other words, the soluble phosphate of the superphosphate was completely fixed and retained by the soil. On the other hand, the sulphate of the superphosphate is freely washed away and and with it part of the lime of the superphosphate: the figures for magnesia and soda, however, show that the addition of superphosphate also increases the amount of these bases which are removed by the drainage. In other words, an interchange of bases has taken place in the soil and a certain amount of soil magnesia and soda have combined with the sulphuric acid of the superphosphate, no doubt replacing part of the lime.

In the case of Tank IV., to which muriate of potash was applied at a rate considerably greater than is usually given in practice, the potash was entirely fixed, little more appearing in the drainage than in the case of the unmanured Tank No. I. and not more than in the case of the tank to which sulphate of ammonia was applied. On the other hand, the chlorine is recovered quantitatively in the drainage and with it the bases, lime, magnesia, and soda, all of which are greatly increased as compared with No. I.

After this first period, the tanks were allowed to stand for some weeks, and, as it had been found that the fixation of the ammonia, phosphate and potash applied was practically complete, it was decided to give still heavier dressings. No. II. again received sulphate of ammonia, but this time at the rate of 10 cwts. per acre; No. III. received sulphate of ammonia at the rate of 10 cwts. per acre, and superphosphate at the rate of 20 cwts. per acre; while No. IV. was given sulphate of ammonia at the rate of 10 cwts. per acre, superphosphate at the rate of 20 cwts. per acre and muriate of potash at the rate of 10 cwts. per acre. Distilled water was then added and drainage collected. It was found that the fixation of the ammonia, phosphate and potash was still good, even in the case of Tank IV., which received all three manures in the excessive dressings stated. It was therefore decided to give another dressing at the same rate, after which water was again applied and drainage collected.

During both the second and third periods, as in the first period, the distilled water was applied to the tanks at a rate which would represent a heavy rainfall of about 1½ inches per week. Water was never applied at a greater rate than half an inch per day.

Table II. shows the nitrogen, phosphoric acid, potash, sulphuric acid, etc., which had been applied to each tank in the three manurings which had been given them, and the materials recovered in the drainage during the three periods of drainage collection which followed. In the three periods, Tank II. had received sulphate of ammonia at the rate of 25 cwts. per acre; Tank III. had received sulphate of ammonia at the rate of 20 cwts. per acre, together with superphosphate at the rate of 50 cwts. per

acre; while Tank IV. had received sulphate of ammonia at the rate of 20 cwts. per acre, superphosphate at the rate of 40 cwts. and muriate of potash at the rate of 25 cwts. per acre. The results, which are given in Table II., show that even when applied in these very large dressings to Tanks II. and III. no material amount of ammonia was washed through in the drainage; but on Tank IV., where, in addition to sulphate of ammonia and superphosphate muriate of potash was applied, a small but distinct amount of ammonia was found in the drainage. On the other hand, it was found that in Tank II. the nitrogen applied as ammonia was still quantitatively recovered in the drainage as nitrate.

TABLE II.

DRAINAGE TANK EXPERIMENTS.

Materials Applied and Recovered, stated as Pounds per Acre.

First, Second and Third Periods.

Tank	I.	II.		III.		IV.	
	Unmanured	Sulphate of Ammonia		Sulphate of Ammonia and Superphosphate		Sulphate of Ammonia, Superphosphate and Muriate of Potash	
	Recovered	Applied	Recovered	Applied	Recovered	Applied	Recovered
Nitrogen as Ammonia	½	593	1	475	1½	475	8½
,, Nitrate .	244	...	835	...	677	...	758
Phosphoric Acid .	3	...	2	836	3	676	3
Sulphuric Acid . .	234	1605	1667	3226	2786	2873	2585
Chlorine . .	94	...	106	5	114	1369	1459
Lime	481	...	2044	1586	2367	1287	2966
Magnesia . . .	85	...	532	50	570	48	603
Potash . . .	25	...	38	...	38	1360	185
Soda	250	...	462	...	572	...	768

The great amount of phosphate applied to Tanks III. and IV. was completely fixed in the soil, no more phosphate was found in the drainage of these tanks than in the drainage of Tank I., and in all cases the total amount of phosphate washed from the soil was practically negligible.

As the amount of potash applied increased, more of it began to appear in the drainage, and it will be seen from the table that, over the whole three periods, about 12 per cent. of the potash applied was recovered in the drainage, after deducting from the total recovered in the drainage an amount equal to that found in the drainage of the unmanured tank.

The chlorine applied to Tank IV. was recovered quantitatively, and a great part of the sulphate applied to Tanks II., III. and IV. was also found in the drainage. With the great increase in the amounts of sulphuric and hydrochloric acids washed through in

the drainage, the amount of bases found in the drainage also increased greatly. As in the first period, lime and magnesia showed the biggest increases, but soda also showed a great increase in Tanks II. and III., and a still greater one in Tank IV.

After the tanks had had a rest for a few weeks, the surface was cultivated to a depth of about 4 inches by turning it over with a spatula, and a still heavier dressing of manure was then given to each tank. Sulphate of ammonia was applied to Tanks II., III. and IV. at the rate of 20 cwts., and superphosphate to Tanks III. and IV. at the rate of 40 cwts. per acre, and muriate or potash to Tank IV. at the rate of 20 cwts. per acre. In this way Tank II. received an excessively heavy dressing of sulphate of ammonia, and Tank III. an excessively heavy dressing of both sulphate of ammonia and superphosphate, while Tank IV. received both of these and also muriate of potash in excessive amount. The drainage was then collected until it was found that all the chloride applied had been recovered from Tank IV., and that practically no more chlorine was coming away from this than from the other tanks.

After these heavy dressings had been applied, a considerable amount of time was required and the application of much water before all the chlorine and nitrogen applied were recovered in the drainage. The collection of the drainage took place in two parts. After a considerable amount of drainage had been recovered, the application of water to the tank was stopped and the drainage was analysed. It was then found that all the nitrogen and chlorine had not been recovered, so more water was added and drainage again collected. A considerable time had elapsed, however, before this was done, and the soils in the tanks had become very dry meantime. When another large quantity of drainage had been collected, that also was analysed, and Table III. shows the total results obtained from the whole of the drainage collected in both parts of this final period.

The results obtained in the final period, when excessively heavy dressing of manures were given, are specially interesting. They show, first of all, that we are now overcoming the capacity of the soil to fix ammonia. A little ammonia was recovered as such in the drainage of Tank II., while a little more was recovered in the drainage of Tank III., to which superphosphate was applied as well as sulphate of ammonia. In both these cases, however, the amount recovered is very small compared with the amount added. In Tank IV., however, to which muriate of potash as well as superphosphate and sulphate of ammonia was applied, a considerably greater amount of ammonia appeared in the drainage. Evidently, therefore, the addition of a large amount of muriate of potash lessens the capacity of the soil to retain the ammonia. This might have been anticipated, as ammonia and potash are somewhat similar in their affinities, and will compete with one another in using up the fixing power of the soil. In every case, even in Tank IV., by far the greater part of the nitrogen applied

is recovered as nitrate in the drainage. Indeed, the nitrate recovered in the drainage is considerably greater than that applied as sulphate of ammonia. It will be noted that, if the amount of nitrogen recovered as nitrate from Tank I. be added to the nitrogen applied as ammonia to Tanks II., III. and IV., the total is about 100 lbs. less than the nitrogen recovered as nitrate from these tanks. It will be seen, then, that the excessive manuring has in these cases stimulated the production of nitrate from the materials naturally present in the tanks.

TABLE III.

DRAINAGE TANK EXPERIMENTS.

Materials Applied and Recovered, stated as Pounds per Acre.

Final Period.

Tank	I.	II.		III.		IV.	
	Unmanured	Sulphate of Ammonia		Sulphate of Ammonia and Superphosphate		Sulphate of Ammonia, Superphosphate and Muriate of Potash	
	Recovered	Applied	Recovered	Applied	Recovered	Applied	Recovered
Nitrogen as Ammonia	½	475	1¼	475	3½	475	13¼
" Nitrate .	193	...	774	...	792	...	776
Phosphoric Acid .	1	...	1	676	1	676	1
Sulphuric Acid . .	457	1356	1716	2866	3216	2872	3335
Chlorine . . .	66	...	73	4	73	1096	1164
Lime	501	...	1814	1282	3020	1285	2916
Magnesia . . .	120	...	302	39	216	46	236
Potash . . .	20	...	28	...	37	1088	978
Soda	89	...	282	...	311	...	560

Even when an excessive dressing of phosphate, at the rate of 2 tons per acre of superphosphate, is applied to Tanks III. and IV., no more phosphate appears in the drainage than was found in the drainage of Tanks I. and II. In other words, even when these very great amounts of superphosphate are applied to the soil, the soil is capable of completely fixing the whole of the soluble phosphate. In the four periods of the experiment, Tank III. received a dressing equal to 90 cwts. per acre of superphosphate. Nevertheless, no more phosphate appeared in the drainage of this tank throughout the whole period of the experiment than in the drainage of No. I. and No. II., which received no phosphate at all. The amount of soluble phosphate applied to No. III. during the whole period of the experiment was as great as would be given to a heavily manured soil in ordinary practice in forty or fifty years.

The case of potash is very interesting. In the first period when a comparatively small dressing of muriate of potash alone was given to Tank IV., very little potash was washed away in the drainage. When the dressing was greatly increased in periods

three and four, considerably more potash was washed away, but the great bulk of the potash was still fixed and retained by the soil. During the final period, however, the power of the soil for fixing potash has apparently been almost completely overcome, and about 90 per cent. of the potash which was applied to the soil was found in the drainage. The loss of potash is therefore progressive. When potash is applied in ordinary amounts such as would be used in practice, it is almost completely fixed and retained by the soil. It is not, however, so completely retained as are phosphate and ammonia, and the power of the soil for retaining it is more easily overcome than in the case of phosphate and ammonia. When excessive dressings of potash are given we can gradually overcome the power of the soil for fixing it and progressively large amounts appear in the drainage, until, finally, the soil almost loses its power of fixing the potash, and nearly all that applied comes through in the drainage.

CONCLUSIONS.

The soil of Craibstone is slightly sour, shows a considerable lime requirement as tested by conventional methods and contains no carbonate of lime. Typical weeds of sour soils, such as spurry or yarr, are plentiful upon it, and turnips readily suffer from finger-and-toe. Nevertheless, when it is left unlimed for long periods, nitrification continues and the soil does not become much sourer, even when manures like sulphate of ammonia and superphosphate are regularly used. On this soil liming is useful in preventing finger-and-toe, and in checking the growth of certain weeds, but it does not appear otherwise to have the effects which one has been led to expect from the liming of soil which is very deficient in carbonate of lime. Our views on this subject have largely been formed from experiments which have been made upon soils in the south-east of England, such as the soil of Woburn, which was, until lately, the experimental farm of the Royal Agricultural Society of England. At Craibstone we do not obtain similar results to those which have been obtained at Woburn, and the soil does not show those indications of extreme lime hunger which we have been led to expect in soils quite deficient in carbonate of lime.

The drainage experiments dealt with in this paper give the following results for soil of the Craibstone type :—

(1) Immense amounts of ammonia, as great as would be added in practice in the cause of many rotations, can be added to this soil in the form of sulphate of ammonia with or without other manures, without any material amount of ammonia being lost in the drainage.

(2) Nitrification takes place readily and rapidly in the soil, and all the ammonia added can quickly be recovered in the drainage in the form of nitrate. The want of

carbonate of lime, therefore, does not in any way check nitrification.

(3) Soluble phosphate in the form of superphosphate, even when given at the rate of several tons per acre, is completely fixed by the soil, and no more phosphate appears in the drainage than in the case of an unmanured soil. There is no danger of any phosphate being washed away from the soil in practice, no matter how freely soluble phosphates are used.

(4) Potash is less completely retained by the soil than either phosphate or ammonia. At the same time, when used in such quantities as are likely to be used in practice, it is almost completely retained by the soil, and only very small amounts are lost in the drainage. There is, therefore, little danger of potash being lost from the soil in more than trifling amounts under practical conditions.

(5) Sulphates and chlorides as well as nitrates are freely washed away in the drainage.

(6) Along with these acids, bases are washed away and the drainage is practically neutral. The chief bases found in the drainage are lime, magnesia and soda, with comparatively small quantities of potash. Lime is found in the greatest amount, and magnesia and soda, as a rule, in somewhat similar quantities. The amount of these bases washed away in the drainage is greatly increased by manuring with sulphate of ammonia, superphosphate and muriate of potash, which necessarily increase the amount of sulphuric, nitric and hydrochloric acid found in the drainage. These experiments show that, even when such soluble manures are used in far greater amounts than are ever likely to be used in practice, there is no danger that the soil will not be able to supply sufficient bases for all practical requirements over a long period of years.

Previous work carried out in Aberdeen indicates that Craibstone soil contains large supplies of unweathered or partially weathered compound silicates like felspars. In these silicates, potash, soda, lime and magnesia are found. The source of the bases washed away in the drainage in combination with sulphuric, nitric and hydrochloric acids is to be found in the compound silicates of the soil. The investigations which are being carried on in Aberdeen indicate that soils of the Craibstone type are by no means rare in Scotland, but that, probably, they are to be found over a large part of the country. It is also probable that they cover extensive areas in the North and West of England and in Wales.

The very laborious analytical and routine work of the experiments recorded was all carried out by my assistant, Mr H. D. Welsh, with great care and accuracy. I wish to express my indebtedness to him for the trouble he took over this work.

AGRICULTURAL CO-OPERATION IN DENMARK.

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SEVERAL books and innumerable articles have been written on Danish agriculture. The principal features of the system of practical farming and of agricultural organisation in Denmark are well known, and it is, therefore, proposed in this paper, while giving a short sketch of the methods and results of Danish co-operation, to avoid as far as possible unnecessary repetition of what has been better said elsewhere. The present purpose is rather to record the impressions derived from a short but fairly intensive enquiry in the country, during which the object chiefly kept in view was to ascertain the extent of state intervention in the branches of the industry particularly under consideration, and also the causes underlying certain special developments in Danish agriculture as contrasted with the system carried on in Scotland.

Comparative Statistics.- A very brief statistical comparison may be of use as a preliminary survey. The total area of Denmark is approximately 10⅜ million acres, or not much more than half that of Scotland, which is 19 million. But when the areas of agricultural land are taken, the ratio is almost reversed, the figures being about 8⅓ million acres for Denmark (in 1919) and 4¾ million for Scotland; this, however, is excluding the large extent of Scottish mountain and heath land used for grazing. That is to say, in Denmark about 78 per cent. of the land is cultivated and in Scotland about 25 per cent. The population of Denmark, which in 1801 numbered 929,000, amounted in 1921 to 3,267,831 (excluding the Faeroe Islands); in Scotland the population in 1801 was 1,608,420 and in 1921, 4,882,288. As regards density, the Danish figures show that in 1921 there were on the average 307 persons per 1,000 acres over the whole country, and 392 per 1,000 acres of cultivated land; for Scotland the corresponding numbers are 257 and 1028.

Looking to the uses to which the agricultural land is put we get the following table of the actual areas under the principal crops in 1919 and the proportions of that land which they occupy[1]:—

	Denmark.	Scotland.	Denmark.	Scotland.
	Acres.	Acres.	Per Cent.	Per Cent.
Cereals and Leguminous Crops (harvested as grain) . . .	3,086,000	1,378,318	37·0	29·0
Potatoes	252,000	154,596	3·0	3·2
Root and Forage Crops .	879,000	455,670	10·5	9·6
Grass and Clover . .	3,328,000	2,746,130	39·9	57·8

[1] In the *Danish Statistical Year Book* for 1922 figures for that year are given in respect of all crops except grass and clover, for which the latest figures are for the year 1919. For purposes of comparison of cropping, it has, therefore, been thought preferable to use the 1919 figures for both countries.

The number of live stock of the different classes in 1922 were as follows:—

	Denmark.	*Scotland.*
Horses	575,773	255,000[1]
Cows	1,310,893	452,231
All Cattle . . .	2,525,348	1,146,807
Pigs	1,899,019	150,884
Sheep . . .	441,875	6,684,097
Poultry . . .	19,1000,000	4,600,000[1]

It is to be noted that the number of pigs in Denmark has increased rapidly since these returns were obtained last year and is now estimated at upwards of 3 millions.

Scottish and Danish Systems of Agriculture.—These figures, and particularly those relating to live stock, bring out the main differences between Scottish and Danish agriculture. Denmark, as a whole, is naturally adapted for agriculture. Its highest elevation is only about 550 feet above sea level, and though the land is for the most part light and of poor quality compared with our best Scottish soils, it is easily cultivated and, with a fairly heavy rainfall, is quite well suited for arable farming and especially for the growth of root and forage crops. Further, the prosperity that has followed on the adoption of an appropriate system of farming and the successful organisation of the industry has enabled the farmers to purchase relatively large quantities of concentrated feeding stuffs and artificial manures, with a consequent all-round increase of fertility. Thus the consumption of oil cakes has increased from 22,000 tons in 1880 to 417,500 tons in 1921, Denmark now taking 75 per cent. of the total American output. In the same period the average yield of wheat has increased from under 31 bushels to about 36½ bushels per acre.

The prevailing system in Scotland is one of mixed farming, with a predominance of stock-raising and of beef and mutton production. The system of cropping in Denmark is not very widely different from ours, but the basis of Danish farming is milk-production; the cow is the central figure in the agriculture, and indeed in the whole economic system, of the country. Up to the sixties of last century grain-growing was the staple part of the industry, most of the surplus produce going to Germany and to England after the repeal of the Corn Laws. The introduction of protective tariffs in Germany struck the Danish farmer a heavy blow, while the rapid exploitation of the accumulated fertility of the prairie lands, which were mined rather than cultivated, and the consequent flooding of the European markets with cheap corn, added greatly to his difficulties. Indeed, had his steps not been directed into the paths he now follows, he, and with him his country, would have found themselves during the agricultural depression of the eighties and nineties in a serious plight. In England, and, though in less measure, in Scotland, the farmers found a way out by laying their land down to grass, thus reducing their labour bills and at the same time altering their chief product from crops to

[1] Approximate.

stock and so avoiding the full force of American and Canadian competition. Assistance given by many landlords, whose reserve capital acted as a sort of fly-wheel, also helped to keep British farming moving more or less steadily through its difficulties.

In Denmark, a different solution had to be found. It is difficult to establish good permanent pasture on poor, light land, and the Dane had not, therefore, a very ready alternative to arable cultivation. Even at that time there were fairly large numbers of small holders, many of them proprietors, and for them there was no landlord wifh his capital to float them over the shallows. Protection was suggested, as a means of salvation, but with a limited internal market it is doubtful how far it would have been effective even as a temporary measure of relief. At any rate the proposal was rejected by the farmers themselves, and the leaders of the time, with great foresight and understanding, urged the adoption of the two remedies that were to prove the foundation of Danish prosperity, dairying and co-operation. By these means the arable cultivation of the land would be maintained and the products of that cultivation would be enabled to hold their own in a large and ready market.

Co-operative "stores," formed on the English model, though they did more by way of producing and purchase than the English organisations, became established in Denmark in the seventies, and it was in 1882 that the first co-operative dairy was started. The progress of the movement was slow at first but it gradually gained momentum until there are now, distributed over the whole country, no fewer than 1465 dairies which receive the milk from about 83 per cent. of all the milch cows in Denmark. The first co-operative slaughterhouse was opened in 1893; now of the fifty slaughterhouses in the country, forty-six are run by co-operative societies. Poultry-keeping, while it remains almost entirely a "side-line" on the farms and small holdings and not a specialised and independent branch of farming, has also benefited and grown enormously as the result of co-operative collecting, grading and marketing.

Some General Effects of Co-operation in Denmark.—Before going on to look in greater detail at each of these three departments of Danish agriculture, it may be of interest to note one or two outstanding effects of the movement that was started forty years ago.

Mention has already been made of the increased fertility of the land as shown by the greater yield of wheat. But when we come to examine the total output of the land we see an increase that betokens far-reaching improvements and radical alterations of methods, the results, it may be believed, very largely of the new spirit of progress that animated the Danish farmer and the material prosperity that attended his efforts. The Danish Ministry of Agriculture give the following table showing the average annual produce of the land, the crops other than corn (potatoes, mangolds, hay and straw) being expressed in corn units in accordance with their relative nutritive values:—

Year.	Corn Units (Kilos Corn). Total.	Average Crop Per Hectare (2½ Acres).
1879-83	3·05 million tons.	1260 Kilograms.
1889-93	3·46 " "	1363 "
1899-1903	4·03 " "	1556 "
1909-13	5·40 " "	2090 "
1914-18	4·75 " "	2742 "
1920	5·43 " "	2482 "

During the period shown, owing to increases in the yield of individual crops and to alterations in the system of cropping, the average output per hectare has thus been practically doubled—a very remarkable achievement.

As an instance of the alteration of system, it may be noted that the area under roots has increased from 64,000 hectares in 1880 to 431,000 hectares in 1921; in the former year these crops occupied only 2·6 per cent. of the cultivated land (excluding grass) while in the latter year it was over 14 per cent. It is on the increased quantity and the improved quality of the root crops—of which beets and kohl-rabi are the most extensively grown—that the winter dairying largely depends.

In 1880 the number of cows in Denmark was 898,000; in 1922 it was 1,311,000. The total number of cattle kept in the country increased in the same period from under 1½ million to over 2½ million. The development of pig-keeping is shown by the fact that in 1880 the number was a little over half a million, while now it is nearly six times that number.

The following table of annual average exports epitomises very clearly both the extent and the character of the development of Danish agriculture:—

Year.	Export from Denmark of Butter.	Bacon and Ham.	Eggs.
	Mill. Kg.	Mill. Kg.	Mill. Scores.
1866-70	4·9	5·0	0·05
1871-75	10·6	7·0	0·6
1876-80	13·5	4·7	1·3
1881-85	15·3	7·9	2·7
1886-90	30·7	24·0	5·1
1891-95	51·6	41·3	6·5
1896-00	57·4	64·9	12·0
1901-05	75·6	76·4	18·2
1906-10	86·3	95·4	18·3
1911-15	82·6	130·7	20·1
1916	95·8	104·7	24·1
1917	61·5	81·9	22·2
1918	14·7	2·7	16·4
1919	36·6	0·9	17·0
1920	74·8	42·4	27·3
1921	92·1	85·3	32·4

The actual methods by which this great development has been secured and is being carried on have often been described; in particular they are set out fully and authoritatively by Mr Harold Faber in his book *Co-operation in Danish Agriculture.* It seems unnecessary, therefore, to give more than a brief outline here.

Co-operative Dairies.—Each of the 1465 dairies has been established by the farmers (including small holders) combining together on their own initiative, without state intervention or assistance of any kind, advisory, administrative or financial. The same thing is true of all successful Danish co-operation; it springs from the people themselves; it is managed and tended by them; it grows and flourishes without external support or shelter. Indeed this seems to be an essential to success for there are recent instances on record in which special branches of co-operation that have been, as it were, grafted on from without instead of having been originated by the farmers themselves, have quickly withered and failed. Such for example are movements for the co-operative marketing of the potato crop, and for the establishment of condensed and dried milk factories (the latter, however, have been taken over and reorganised by the farmers' societies and are now likely to succeed). The importance of the principle seems to be one of the most outstanding lessons to be learned from the history of Danish co-operation.

When a group of farmers combine to set up a co-operative dairy they usually obtain a large proportion of the necessary capital for buildings, etc., from a private or a co-operative bank, all the members of the new society being jointly and severally liable for repayment of the loan. In the larger societies the collecting of the milk from the holdings may be done from the central institution, but in the smaller societies the haulage is usually done by one or more of the members whose carts go round collecting the milk and also bringing back the skim milk, which is pasturised before being returned. Allowance is, of course, made to the members who undertake the haulage. In a very few of the societies the members are paid on the basis of the quantity of milk supplied, bnt this system is almost obsolete, payments being based in nearly all cases on the amount of butter produced from the milk. For this purpose the butter fat content of each member's milk is tested every day. In many of the societies payments are now increased or diminished according as the milk is above or below the average standard as regards general quality and cleanliness, and in the most up-to-date societies a bacterial count of each individual milk supply is made every day. This practice is of recent introduction but is said to be growing with the wider understanding that cleanliness of milk is to be measured not merely by the absence of foreign solid matter but by the reduction of harmful bacteria.

The affairs of each dairy are managed by a committee of the members and each society makes regulations for the control of each cow-house, and for the handling and cooling of the milk at

the farm. These regulations must be carefully observed and it is of course an invariable rule that no member may sell any of his milk otherwise than through his society. Each member's account is made up every week and a payment made to him of something less than the value of the milk he has supplied during the week. This value depends mainly, as stated above, on its content of butter fat. The price of milk turns thus on the price of butter and this is determined weekly by a committee meeting at the Copenhagen Bourse and consisting of six persons—three merchants and three representatives of dairy farmers' associations. This price is in effect the world market price. Every smallholder accordingly, who is a member of a society, obtains this world price for his produce—the milk of perhaps only one cow—equally with the largest producers in the country.

In this connection it is interesting to note how the quality and the price of "farm butter," *i.e.*, butter made on the farms and small holdings as distinct from the large estates—have improved with the adoption of co-operative methods. In the year 1882, when the first co-operative dairy was established, butter from the large estates was quoted at 142 kroner per 50 kilos, while farm butter, on account of its inferior and heterogeneous quality, was quoted at only 88 kroner per 50 kilos—a price said to be quite unprofitable. At a large exhibition in Copenhagen in 1888 some surprise was caused by one dairy gaining a silver medal for butter exhibited; at a similar exhibition in 1900, at which the whole country was represented, all the 46 silver medals and 202 of the 210 bronze medals were gained by co-operative dairies. The result of the general raising of the standard of quality has been that quotations for second and third class butter have been dropped, as all Danish butter can be sold at the top market price.

An annual meeting of the members of each dairy is held when all accounts, etc., are submitted and a bonus is declared from the surplus in hand, after making due allowance for management, upkeep of plant, etc., etc. The dairies work together through provincial co-operative societies, which again are combined in a federation known as the United Danish Co-operative Dairies.

As already noted, milk from about 83 per cent. of all the cows in Denmark is sent to co-operative dairies. The average number of members of the dairies is 144, possessing on the average 869 cows amongst them. The average amount of milk marketed from each cow is about 570 gallons, *i.e.*, exclusive of the milk consumed on the holdings, which brings the total average production per cow up to 660 gallons. For each kilogram of butter 25 kilos of milk are required, which means that the average proportion of butter fat in the milk is 4 per cent.

The cost of running a dairy works out on the average to 27·56 kroner per 1000 kilograms of milk (= 220 gallons) where the milk is made into butter, and 17·91 kroner where it is made into cheese.

Of the butter produced, about one third is sold through

co-operative selling associations, and efforts are being made to increase this proportion. The remaining two thirds are bought up by private firms, most of them British. Every keg is marked with the name of the dairy in which the butter is produced and with an identifying number. If the keg is to be branded with the "Lur" brand, the butter must come under Government control, in which case a sample must be sent, when required by the police, to the control station in Copenhagen where it is tested for moisture, flavour, texture, etc. If the proportion of moisture is found to exceed 16 per cent. the right to use the brand, which is the official mark of quality, is withdrawn.

All perishable food-stuffs are carried at reduced rates on the Danish State railways, but apart from this no preferential rates are allowed for the carriage of dairy produce.

Whole Milk, Condensed Milk and Milk Powder.—Before the war considerable quantities of whole milk were sent from Denmark to Germany, much of it going to Berlin which is from eight to ten hours distant from Copenhagen by train. This market has shrunk greatly, and it was partly because of this that the efforts, already referred to, were made to establish co-operative factories for the production of condensed milk and milk powders. This new trade, after a rather unfortunate start, owing partly to too heavy capital expenditure and more particularly to its having been set going in the wrong way ("built from above instead of being allowed to grow from the bottom," as one informant put it), has now been reorganised and is assuming substantial dimensions. In 1922 the total production of these products amounted to 23,367 tons, of which Great Britain took 18,959 tons.

One of the largest and best known co-operative dairies in Denmark is the so-called "Trifolium," part of whose business is to supply fresh milk to Copenhagen, while it also manufactures large quantities of butter and cheese. Its headquarters are at Haslev and it has a large collecting and distributing station in Copenhagen where additional milk is also collected and where all the milk to be retailed is mixed, cooled and bottled. The quantity of milk received at Haslev amounts to 10 million gallons annually and the quantity of whole milk distributed by the Society in Copenhagen is 50,000 litres (approximately 12,500 gallons) per day. The various supplies of milk are weighed and tested daily and over or under payments are made to the farmers on a basic standard of 3·35 per cent. of butter fat. Various private companies compete in the Copenhagen trade, but in spite of this the prices to the consumers are usually high and have been known to amount to three times the price paid to the producers.

The Trifolium Society, as well as some of the companies, sell milk of a special quality known as "children's milk." For the production of this milk, the producing farms are inspected by an official veterinary officer every week, and the cows are periodically tested for tuberculosis. All the children's milk is separately handled and bottled in sterilised bottles which are specially labelled.

The price charged for this milk is from 25 to 33⅓ per cent. higher than the normal, but even at this extra cost it is said to find a ready and growing sale. It is interesting to note that none of the milk sold by the Trifolium Company, whether the general supply or the children's milk, is subjected to any pasteurising process.

Milk Recording.—In 1895 the first Danish Milk Recording Society was formed by thirteen farmers, who owned together just over 300 cows and who combined to employ a man to record the yield of milk and its content of butter fat from each cow on their farms. Other groups of farmers followed suit as the practical value of the information obtained and its importance in cattle-breeding became recognised. Now there are in Denmark 825 recording associations dealing with 25 per cent. of all the cows in the country, or upwards of 300,000. The movement is still growing and it seems not unlikely that in course of time the majority of the cows in Denmark will each have its record. An official is employed by a society, or group of societies, according to their size, who visits each farm at least once per month and sometimes oftener, and who checks not only the yield and the butter-fat but also the amounts and kinds of the foods used, which are converted into terms of food units, as it is considered of importance to obtain particulars not only of what may be called the finished product but also of the raw material from which it is derived. All the individual records are sent to a central office in Copenhagen where they are tabulated, together with particulars as to the date of calving, the purpose for which the calf is to be used, etc.

A state grant of not more than £6700 per annum is given to the societies, each of which, under certain restrictions as to numbers, methods, etc., may receive a grant of not more than £11. These grants, it should be observed, are of the nature of development grants, the object of the government in giving them being the general improvement of the cattle in the country; while they are given to bodies acting co-operatively, they can hardly be regarded as a measure of state support to agricultural co-operation in the ordinary sense, that is to say co-operation the immediate purpose of which is to secure better trade to the co-operators.

With regard to the use which is made of the records for cattle-breeding purposes, Professor Frederiksen writes:—

> "Soon after the recording societies were founded, the information collected by the societies began to be used in the more official side of dairy cattle breeding. Regulations were made that bulls of the dairy breed could not receive prizes at cattle shows unless information was furnished about the yield of milk and butter of their dams; later the same regulations were extended to apply to cows, and now at Danish cattle shows prizes may only be awarded to such dairy cattle the yields of which have been recorded. Cows are admitted only when there are records of their own yield of milk and butter for each

year, and bulls only when such information is given of their dams. At the majority of cattle shows information as to the yield is considered just as important as the exterior appearance of the animal.

"In the so-called cattle breeding societies or bull clubs only those bulls are used whose dams have recorded yields."

Since 1900 detailed investigations have been made into the influence of bulls with a "recorded" ancestry on the productiveness of their progeny, and Professor Frederiksen, in the paper from which the above quotation is made, shows how the best use can be made of the information derived from these investigations.

In the sixteen years from 1899–1900 to 1915–16 the average standard of production of all the recorded cows on the Danish Islands has been raised by the following amounts:—total milk 16 per cent.; proportion of butter fat 8 per cent.; total yield of butter 27 per cent. In the same period the average amount of milk per cow delivered to the Danish dairies increased from 476 gallons to 572 gallons and the proportion of fat from 3·40 per cent. to 3·63 per cent. In other words, the yield of milk from all Danish cows increased 20 per cent. and the yield of butter 27 per cent. Other factors may have contributed to this result, but there can be little doubt that it is largely due to the growth of milk-recording and to intelligent use of the records.

Co-operative Slaughterhouses and Bacon Factories.—The general principles of organisation on which these are conducted are similar to those of the co-operative dairies and need not be described. As already noted, forty-six of the fifty bacon factories in Denmark are co-operative and these receive about 85 per cent. of the total production of fat pigs in the country. While each factory is an independent undertaking, the various societies work together through the United Danish Co-operative Bacon Factories in Copenhagen.

There is an official brand for the bacon, similar to that used for butter. At the slaughterhouses every pig is inspected by an official veterinary officer, who either gives or withholds the brand. The veterinary inspector is an official appointed by the Government to whom alone he is responsible; the society whose animals he inspects have no control over him but nevertheless it is they who pay his salary, the amount of which is fixed by the Minister of Agriculture. This affords a rather interesting example of Government control without Government expense.

The bacon-producing societies are alive to the importance of improving the breeds of pigs and contribute to the breed societies, which operate both by selection and crossing of the native breeds and by importing boars from England. They also assist financially in the maintenance of the state breeding and experimental stations.

The Danish Co-operative Egg Export Society.—This is the only Society which organises the marketing and export of eggs, but as it operates by means of branches throughout the country the system does not differ much in its practical working from that

in which there are independent local co-operative societies working together through a central federation. Some sporadic efforts had been made to develop the egg trade co-operatively, but it was not until the formation of this society in 1895 that a firm foundation was established on which a substantial export trade could be built up. The chief task of the society was to ensure a uniformly high standard of quality of its goods, a standard in which the British buyers would have confidence. This it did by making it a rule that every egg should be marked with the number of the member sending it and the number of the branch to which he belonged. By these means, combined with the careful testing of all eggs, it became possible to throw the loss from bad eggs back on the producer, and thus give him the strongest inducement to send his eggs when they were fresh. The society at first met with "fierce competition" from private exporters; but by maintaining rigidly its standard of quality it was soon able to pay higher prices to its members than could those traders who dealt in eggs which had been held up for a rise in the market, either by the farmers or by the traders themselves, and which were consequently of very doubtful and unequal quality by the time they reached the British consumers. As Mr Faber says, the action of the society has shown the producers, private dealers and exporters alike, that "it is a short-sighted policy to take a momentary advantage at the cost of the reputation of the goods. This co-operative reform, more perhaps than any other, has had a far-reaching beneficial effect, far beyond the limits of the trade of the society itself."

The turnover of the society, which in its first year was only 95 tons, averaged in the years 1911-1915 4661 tons. Some increase has taken place since then, but the majority of farmers have not yet joined the society, and the proportion of eggs marketed co-operatively is much less than that of dairy produce and bacon. In 1922 the total export of eggs from Denmark was 36,794 thousand scores (equal to over 41,000 tons if the average weight per egg be taken at 2 oz.) of which about eight-ninths went to Great Britain. These are big figures, but nevertheless it seemed to the writer that the industry in Denmark could be considerably expanded by improvement of the breeds of poultry and in the methods of keeping them. Many of the birds seen about the farms were of a rather nondescript type, and they did not seem to be looked after in any systematic way.

Co-operative Credit and Banking.—About 90 per cent. of the farms and holdings in Denmark are owned by their occupiers, and a large number of them are debtors to their various credit societies. When a loan is required the society sends an official, an employee of its own, to assess the present sale-value of the applicant's land and stock. A loan of 50 to a maximum of 60 per cent. of that value may then be made by means of bonds issued by the Association, and negotiable through a banker or broker.

The Credit Associations have nothing to do with co-operative banking, which is carried on by a central co-operative bank, and

also by village banks. It is from these banks that all short term loans are obtained, either on the security of the farm, if not already too heavily mortgaged, or on the personal caution of two known persons. The central bank was started in 1914, and the establishment of local co-operative banks is a recent and apparently growing movement. Time did not permit of any extensive inquiry into this part of the subject.

Co-operation among Allotment Holders.—The allotment movement is a very popular one in Denmark. Official figures of the numbers could not be obtained, but for a considerable distance on all the landward sides of Copenhagen one passes through areas devoted largely to allotment gardens, while Odensee, for example, with a population of about 50,000, is said to have 1000 allotments. The majority appeared to be from say $\frac{1}{12}$th to $\frac{1}{4}$ of an acre in extent. On many of them little wooden dwellings are built in which the families go to live during week ends and holidays, and in some cases for the summer months. Good means of communication are afforded by the suburban railways and tramways and by the smooth flat roads, on almost all of which a part is specially prepared and reserved for cyclists, who stream over them in amazing numbers. The allotment holders generally consist of a group of persons who have combined together to purchase or lease the ground on which their allotments are formed, and who continue to co-operate in the purchase of seeds, plants, manures, implements, etc.

Other Co-operative Organisations.—It is possible for a Danish farmer to be a member of over forty co-operative undertakings, and many, in point of fact, are members of ten or a dozen or more. There are large purchase societies throughout the country, from which farmers obtain implements, manures, feeding-stuffs, etc., as well as household goods. There are also societies dealing with insurance, the improvement of the various classes of live-stock, etc. It is unnecessary to refer to these in detail; it is sufficient here to record the fact of their existence, as showing how widespread is the co-operative principle in Danish agriculture, and how it underlies and pervades the whole industry.

Causes of the Development of Co-operation.—Agricultural co-operation in Denmark has been unequalled in any other country in its rapidity of growth and its far-reaching effects. Scottish consumers have benefited from the results, but those who are interested in Scottish production sometimes ask ruefully, "Why cannot we do the same thing here?"

The question is a natural one, but it hardly states the problem correctly, for obviously there are no compelling reasons why the Scottish farmers should not buy and sell co-operatively if they wanted to. The fact remains, however, that the great majority of them do not, and that co-operation makes relatively slow progress amongst them. It seems better, accordingly, to approach the problem from the opposite angle, and to ask, "Why has co-operation in Denmark developed as it has?" Any endeavour to answer

this question reveals at once that special factors and combinations of factors, many of them differing essentially from anything in this country, have been operative, and that the whole environment has been favourable to the growth of the co-operative organism, which has reacted very quickly to the peculiar influences to which it has been exposed. From an attempt to analyse that environment it is suggested that the following are some of the principal causes that have conduced to the state of co-operative organisation as we find it in Denmark. Several of them are so entangled together that it would be very difficult to arrange them all in order of importance; indeed, the mere separate enumeration of factors so closely interlocked is apt to give an air of unreal simplicity to the problem. It has to be remembered that the ultimate causal force is a very complex resultant, and not merely a series of parallel and independent forces.

1. *Tradition and Temperament.*—Up to about the end of the eighteenth century, the rural life of Denmark was concentrated in village communities, in which the farmsteads and houses were built close together instead of being detached and scattered over the land as they now are. Apart from the ground on which the buildings were erected, and the "toft" or small piece of land immediately adjacent to them, all the land pertaining to the village was held in common, being allotted annually in strips to the peasants so that all might share equally in the good and the bad soils. All the internal affairs of the community were administered by the members themselves. As Mr Faber puts it, "Each village community, in Danish called 'Bye,' was in reality a co-operative society. It had its own law, 'Bye-Lov' . . . . which contained all those rules which the villagers had agreed upon to regulate their joint action. . . . A well-developed spirit of co-operation and home rule existed in the village communities, dating back to very old times, and handed down from generation to generation. Most of the village affairs were regulated by definite rules, the peasants aiding and controlling one another." This last clause is significant; it contains in a nutshell the essential principle of modern Danish co-operation.

After the passing of the Enclosure Laws of 1781 and 1792, the whole system of rural life became changed. Each peasant became the proprietor or tenant of a single, continuous and self-contained piece of land, on which he erected his house and steading. One result of this was that the village communities largely ceased to exist. Nevertheless, even during the first half of the nineteenth century co-operation was not quite dead, and there can be little doubt that what may perhaps be called the co-operative spirit, the aptitude for mutual "aid and control," inherited from past centuries, remained, latent but alive, in the Danish character.

2. *Agriculture the Predominant Industry.*—The absence of mineral resources in great measure excluded Denmark from the "industrial revolution" of other countries; its repercussion on her, unlike its effects in this country, was favourable to her agriculture,

from which she was not diverted to industrial pursuits, and for the products of which a large foreign market was created. At the present time 86 per cent. of the total exports of the country consists of agricultural produce.

3. *Character of the Soil.*—As already mentioned the soil over the greater part of Denmark is not of the kind on which good permanent pastures can be easily established. In the period of agricultural depression she found another alternative to grain-growing in dairying, to which co-operative methods are particularly applicable.

4. *Uniformity of Products.*—In addition to the fact that the dairy industry lends itself readily to co-operation, the general adoption of one system of farming throughout the country, with production mainly of one class of goods—dairy produce and the bye-product, bacon—facilitated organisation and rendered the example of one society easily capable of imitation by another group of farmers.

5. *The Export Market.*—Only a small proportion of the surplus products of the farms could be sold within the country. It was, therefore, essential to the success of the industry that a hold should be obtained on the foreign markets, and that for this purpose a standard and reliable quality of produce should be maintained. It would have been difficult even for large farmers, acting independently, to accomplish this, especially as the chief commodities for export are of a perishable nature. It was, therefore, of obvious advantage to the producers to combine. Further, it is apparent that the necessary massing of produce for export leads to co-operation more naturally than does the diffuse system of sale to large numbers of consuming centres within the producing country.

6. *Small Holdings.*—In Denmark small holdings vastly predominate. The Danish Ministry of Agriculture gives the following table of the numbers of holdings of the various sizes in 1921 (a hectare is approximately 2½ acres):—

			Number of Holdings.
0·55	. . . 1·7	hectare	16,135
1·7	. . . 3·3	"	27,756
3·3	. . . 5	"	23,365
5	. . . 10	"	41,889
10	. . . 15	"	25,494
15	. . . 30	"	43,364
30	. . . 60	"	22,552
60	. . . 120	"	4,039
120	. . . 240	"	916
240 and more	. .	"	419

There are thus over 109,000 holdings of less than 25 acres in extent, 135,000 of less than 37 acres and 178,000 of less than 75 acres. Of the total of 206,000 holdings, only about 5500 exceed 150 acres in area. Perhaps the most striking feature in

the table is the large numbers of very small holdings—holdings on which, even with the aid of co-operation and without extraneous employment, it cannot be easy to maintain a family. Without the adoption of co-operative methods, it is fairly certain that many of the small holders could not have survived as such, and it may be said that, whatever other causes had been at work, force of circumstances would have compelled them to combine together for their mutual salvation. Also, the fact of their being all more or less on an equality as small holders would doubtless render co-operation easier than among occupiers of holdings of very different sizes.

7. *Peasant Proprietorship.*—Without touching on the controversial question of occupying ownership versus security of tenure, it may be permissible to suggest that the fact that 90 per per cent. of Danish agricultural occupiers own their holdings has been a factor in the spread of co-operation. The sense of property is a deep-rooted human instinct, as even the most casual student of child-psychology can testify, and the feeling of ownership is in many cases at any rate a strong stimulus to progress and to efforts to improve the value and diminish the risk of loss of the thing possessed. Those familiar with the effects of the Irish Land Purchase Acts have seen this force at work.

8. *Education.*—It is usually considered that the system of education has been one of the main factors in contributing to the success of co-operation by equipping the people with both general and technical knowledge, and by developing their minds so that they are more receptive of new ideas and more capable of grasping and applying new methods. That it has contributed greatly is no doubt true, though it is possible that its importance has been sometimes over-rated. It can hardly be claimed that the standard of general education in Denmark has been in the past, or is now, higher than that in Scotland, and though technical education, of a fairly simple kind, was earlier incorporated in the Danish system, it is doubtful if that would have greatly furthered co-operation had not tradition, custom and force of circumstances combined together to commend it to the people. Technical education in agriculture has made great progress in Scotland in the last twenty years, but so far there is not very much evidence that a tendency towards co-operation is one of its fruits. It seems to the writer, therefore, that the educational system has hardly been one of the root causes of the great growth of Danish co-operation, but that it has certainly been helpful to the movement once it got started, and that the system as a whole is such as is likely to react favourably on co-operation. For instance, the bringing together of adults for a period of months in the Folk High Schools, by providing opportunity for the discussion of matters of common interest, cannot fail to foster appreciation of the advantages of common action. The benefits derived in this way are probably not less important than the actual acquisition of knowledge in the somewhat crowded curriculum at these schools, where it seems, to a passing

observer at any rate, rather difficult for any subject to be gone into at all thoroughly.

9. *Parliamentary Sympathy.*—Both the Upper and the Lower Chambers, the Landsting and the Folkesting, are dominated by the agricultural interest, and while the majorities do not seem to abuse their powers by giving undue aid, financially or otherwise, to agriculture, the legislative atmosphere, so to speak, is favourable to the industry. Most of the members themselves are probably co-operators and unlikely, therefore, to set the interests of private trading companies before those of the societies when any question affecting both arises.

10. *State Railways.*—The system of State railways provides on the whole fairly good means of communication and transport. As already mentioned, perishable foodstuffs are carried at rates lower than those for other goods.

Conclusion.—To sum up very shortly the chief general impression derived from this inquiry, one may say that agricultural co-operation forms the broad basis on which the prosperity of Denmark rests; that the growth and success of co-operation in the country are the result of a peculiar combination of causes, historical, social and economic, of which several at least of the more important have no parallel in Scotland; and that the movement owes both its origin and its development to the initiative and activities of the people themselves, and not to any propaganda or assistance by the Government.

Among the main deductions to be drawn, when seeking to apply the example of Denmark to Scotland, are that, in the first place, the extended adoption of co-operation by Scottish small holders would be greatly to their advantage. It does not necessarily follow that it would be of equal service to the larger farmers, who are usually able both in buying their raw materials and in selling their products—especially such as grain, meat, mutton and wool—to obtain terms not substantially inferior to those secured by existing co-operative societies. It is true that farmers by combining together might, in certain cases, reduce the costs arising from the intervention of purely distributive agencies; but, as pointed out by Captain Elliot in his article in the *Scottish Journal of Agriculture* for April of last year, the function of the distributor is not without value to the producer. Secondly, the criticism which is sometimes levelled at Scottish agriculturists that they are so backward in co-operation as compared with the Danes does not make sufficient allowance for the special causes which have operated in Denmark. In this connection also it would be interesting to inquire whether the individualism and independence of the Scottish character may not have contributed certain advantages that may in part have compensated for the consequent reluctance to co-operate. Such an inquiry, however, would go far beyond the proper limits of this paper. Lastly, as the experience of Denmark shows clearly that, in that country at any rate, the success of any co-operative movement has been directly pro-

portional to its spontaneity, the considerable expenditure of State funds in fostering and aiding co-operation in Scotland would appear *primâ facie* to be undesirable. It may be replied to this, not unfairly, that the specially favourable conditions in Denmark have rendered State assistance unnecessary; but the general principle appears to be incontrovertible that the intervention of the State should be kept within the narrowest limits that the circumstances will permit. To refer to Captain Elliot's article again, if co-operation is to achieve success in competition with other agencies, and to establish itself permanently and widely in our agricultural system, it must do so on its own merits.

FARM PESTS.[1]

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BIRDS.

The Part Played by Birds in Agriculture.—The recognition that birds play an important part in agriculture is no new discovery. But the fact that they may be grievous pests was impressed upon the notice of the farmer long centuries before he appears to have realised that they may also form his first line of defence against more serious enemies. In their summary fashion the laws of Scotland make this point clear, for whereas, so long ago as 1424, the Scottish Parliament passed an edict for the destruction of Rooks, on the ground that they "does gret skaithe apone cornis," it was not until recent legislation singled out the Lapwing for special protection, that any attempt had been made to protect birds solely on account of their agricultural value.

Yet even a slight knowledge of the general habits of birds ought to have made man pause, and ought to have led to some consideration of their place in the balanced order of nature. For it is a common-place of the naturalist's lore that some birds are, throughout their life, wholly insectivorous, and some insects are amongst the most persistent and serious of the farmer's enemies. Even where adult birds feed upon vegetable matter almost exclusively, as in the case of the Red Grouse, or largely, as with the Sparrow, their young feed themselves or are fed, with few exceptions, wholly on a diet of insects and other small creatures, such as worms. Further, observation has shown that many birds of prey, Buzzards, Kestrels and Owls, feed to a great extent upon the vermin of the fields, rats and mice, moles and the like, and such vermin also must be numbered amongst the serious pests of the farm. The most superficial observation, therefore, would indicate that there is a *primâ facie* case for a consideration of the part played by birds in agriculture.

[1] Articles in this series, dealing with mammal pests, have appeared in the *Journal*, beginning with the July number, 1922.

The Value of Birds to Agriculture: Two Divergent Views.—At the very outset, however, we are met with a serious difficulty; for, even on the most general consideration of the habits of birds, agreement has not been reached as to the ultimate agricultural effect of their activities. We are at once projected into the clash of two opposing factions, the one holding that birds as a whole do more good than harm, the other asserting that on the whole their activities are malevolent, or at any rate neutral, the former having inscribed upon their banner "The Useful Bird," and the latter "The Useful Insect." A short consideration of the divergent views may help to illustrate the factors which have to be taken into consideration, and will assuredly give a vivid impression of the intricacies of the processes which result in what is so simply termed "the balance of nature."

On the one hand, then, we have the naturalists who regard birds as almost altogether beneficial. They consider very few birds to be really harmful, and even as regards pestilent birds they look upon the accusations made as largely exaggerated. The French writer Michelet gave expression to their faith many years ago, "Birds can live without man, but man cannot live without the birds;" and if a bird should on occasion rifle the farmer's crops then they say, "Is not the labourer worthy of his hire." The foundation of this solid belief in the efficacy of birds rests upon a not unreasonable fear at the menace to agriculture made by the multiplication of injurious insects. With intensive cultivation and the increase of the farmer's crops there has been an undoubted and serious increase of the insect pests which, at one stage or other, destroy the yield of the fields. This menace is actually countered to some extent by the presence of birds, for, apart from the constant activities of the normal bird population, it has been noticed that unwonted multiplication of insects has attracted unwonted numbers of insectivorous birds, which help to redress the balance of nature.

I cannot do better than summarise this point of view in the eloquent words of Michelet, from *L'Oiseau* published in 1850:—"The stingy farmer has not a grain for the creature, which, during the rains of winter, hunts the future insect, finds out the nests of the larvæ, examines, turns over every leaf, and destroys every day thousands of incipient caterpillars. But sacks of corn for the mature insect, whole fields for the grasshoppers, which the birds would have made war upon. With eyes fixed upon his furrow, upon the present moment only, without seeing and without foreseeing, blind to the great harmony which is never broken with impunity, he has everywhere demanded or approved laws for the extermination of that necessary ally of his toil—the insectivorous bird."

On the other hand we have a body of observers, more prominent on the Continent than in Britain, who take another view of the general activities of insects, and in consequence look upon the doings of insectivorous birds from an entirely different standpoint.

They point out that many insects are of the utmost value to the farmer—there are bees, humble-bees and others which fertilise the flowers of many important crops, so that without their agency fruit would not set nor seeds ripen, there are the smaller parasitic hymenoptera which wage a continuous warfare against noxious caterpillars and other insects, there is a whole array of carnivorous beetles which live upon the pests of plant growth, and so on. Indeed, they say, insects, as a whole, probably do as much or more good than harm. They are deliberately and increasingly used by man, even to the extent of being transported from one country to another, simply to combat insect pests upon which they are parasitic.

Now the insectivorous bird does not distinguish between useful insects and harmful insects; it probably destroys as many of the former as of the latter. Nay, they argue, it probably destroys more of the useful kind, for the larvæ of the plant destroyers are frequently concealed within the shelter of the plant they attack, while the larvæ of such as the carnivorous beetles are less securely hidden from the bird's keen eyes. A protagonist of the useful insect theory, M. Sèverin, of the Brussels Museum of Natural History, has calculated that of the nineteen really serious insect pests of Belgium, only two are readily accessible to all the insectivorous birds, and only four are accessible to some of them.

It would seem then that the birds, in their enthusiasm for the destruction of insects, may be doing more harm than good, and that, if the best way to counter insect pests is to encourage the insect enemies of the pests, we ought rather to encourage the useful insect and reduce the numbers of the insectivorous birds which include it in their dietary.

Since these two schools of experts differ so fundamentally on the general question of the value of birds to the agriculturist, it is clear that we must turn from their opinions to the observations on which their claims are based. And here I think it will be found that on each side there has been a tendency to exaggeration, to push theory too far in advance of fact. When an observer states that a family of Tits consumes 24,000,000 insects in a year, and reveals that he has reached this result by calculation from an actual observation of the number of insects carried to the nest in an hour, we feel that he has made a dangerous and unjustifiable leap from the known to the unknown ; and when one investigator credits a couple of Tits with the destruction of some 40,000 caterpillars during the three weeks when the nestlings are developing, while another puts the number at about 3000, we feel that something must be wrong with the primary observations from which so discrepant results could have been deduced.

Even in the case of so familiar a bird as the Sparrow, regarding which it might be imagined that some degree of unanimity had been reached, similar serious discrepancy is apparent in the statements of fact adduced by the partisans of the useful bird and the useful insect. We find that one writer (M. X. Raspail) credits

the Sparrow with the destruction of large numbers of cockchafers during the period of the early nestlings, and in particular selects the heavy egg-laden females to feed its young; while another (M. Noël) states that the Sparrow destroys at a maximum only three chafers a day, and that since these are males, which alone are to be found on the wing during the day, the utility of the destruction is very seriously reduced.

In face of such inconsistent and even diametrically opposed opinions, we are bound to inquire more closely into the actual facts of bird activities, and especially to examine the methods of collecting those facts on which decisions of some moment, regarding the relationships of birds to agriculture, are to be based. The first essential, then, is to get at the facts, to lay at the base of our opinions a firm and unshakable foundation of accurate knowledge. While the question as to whether birds *as a class* are on the whole useful or neutral or harmful, is an interesting one, it is, in the general form, neither a vital nor a pressing question. Although I rank myself with the naturalists who believe that birds perform a great service to humanity, I feel that, for the present, on account of its complexity, this general question of the *rôle* of birds as a class ought to be avoided, and that the best service will be done, alike to science, to agriculture and to the birds themselves by prolonged and intensive study concentrated upon the accurate definition of the standing of each particular species of bird in its relation to the various types of agriculture. Only by such study can a degree of accuracy be attained that will command the respect and acquiescence at once of all scientists and of all farmers.

The Determination of the Food of Birds.—The value, plus or minus, of a bird depends to a very large extent on the nature of its food, so that the first important part of the inquiry is the determination of the bird's diet. This is a more difficult problem than is apparent at first sight, for, in the case of birds resident throughout the year, it involves a knowledge of (*a*) the food at all seasons, and (*b*) the food in different types of agricultural areas.

Many observations on the food of British birds have been made, and it may be well to glance at the methods which have been adopted in collecting information. They fall naturally into three groups:—

1. *Field Observations.*—These constitute the great body of evidence upon which, till very recent times, a bird has been approved or condemned. They embrace casual notes made on a single occasion, where obviously the chances of the food sample being a fair average for the year are remote; observations made by individuals interested from a particular point of view—as when a farmer notes the Rooks at his potatoes, but fails to see them at the grubs in his pasture; or when a game-preserver records the Kestrel carrying off a young game-bird, but omits to record it catching a field mouse—and such observations, reliable as they may be, cannot be regarded as fair samples of the birds' activities; and, lastly, they include careful summaries compiled from many

field observations made throughout the year and over many years. The last find expression in the statements of the food of the various species, to be found in standard treatises on British birds. While they are accurate so far as they go, they are, as a rule, too generalised to meet the requirements I have laid down as essential, in particular with respect to the variations in feeding known to occur in different kinds of agricultural areas. So that while the conclusions drawn as to the status of a bird are often accurate, they are not compellingly accurate, and may fail to gain general assent.

2. *Observations of Food-Refuse.*—A gain in definiteness is made when field observations, which can seldom reveal the specific identity of the food-matter, are supplemented by examinations of the food-refuse contained in the ejected pellets of such as Owls and other birds of prey, in the casts of many birds, such as Gulls and Rooks, or in birds' droppings. These frequently contain identifiable animal- -as well as plant- remains; but in most cases great caution is required before a safe conclusion as to the ultimate standing of a bird is drawn from an examination of food-refuse. For although certain kinds of food may be represented in the ejecta, it is hazardous to say that every kind of food is represented, and it is almost certain that soft-bodied insects and other invertebrates will not appear in their true proportion alongside indigestible vegetable and animal matter.

3. *Examination of Crop- and Stomach-Contents.*—Ornithologists everywhere have concentrated upon the method of examining the actual contents of the crop and stomach of birds, as the only method likely to yield a full and accurate knowledge of wild birds' food. The method is a laborious one, and demands wide and thorough knowledge of the characters by which insects and other lower forms of life are distinguished from each other. This is bound to be so, for the essential value of the crop-content method lies in the fact that it offers actual identification of each item of plant and animal food which a bird has swallowed. The food is often broken and fragmentary, nevertheless every effort must be made to establish its identity, for a partial survey of crop-contents can never afford a clue to the relative quantities of the various materials of the food supply. It has also to be remembered that some of the food materials, such as soft-bodied creatures, are digested more rapidly than others, and that digestion may proceed even after a bird's death; so that the sooner the food-content is examined after a meal the more accurate the reading of the diet is likely to be.

An examination of the crop of an individual bird reveals the character of possibly a single meal, but as a guide to the feeding habits of the bird this may be profoundly misleading. A Blackbird may feed on earthworms in the early morning, and on fruit in the afternoon. A just estimation of the daily diet demands examination of a balanced series of crop-contents, obtained at suitable intervals, which will be determined by the bird's chief feeding

periods during the day. But a further complication arises from the seasonal changes, which, by regulating the supply of food-stuffs, compel most birds to vary their diet throughout the year. To obtain an accurate notion of the annual balance sheet of a bird's food, it is necessary, therefore, to examine not only fair samples obtained at different times of the day, but samples thus collected at every period of the year. Precautions must, of course, be taken, as in all statistical work, to ensure that the samples examined are fair, or unprejudiced samples, and this is a difficulty that tends to make unreliable the results of miscellaneous collection and the deductions drawn from samples sent for examination by all and sundry.

Two methods have been adopted for recording the examination of crop-contents. The first, or numerical method, has been used by the majority of British workers, and consists in the identification and recording of the actual numbers of each item present in the food. The second, or volumetric method, instead of recording numbers and recording in detail, lumps together the insect items in three categories as they effect the farmer, injurious, neutral and beneficial, and measures all items in the food by bulk, as a percentage in the total volume of food. This method has been adopted by the experts in the United States Bureau of Ornithology and has recently been followed by Dr W. E. Collinge in this country.

SOME PRACTICAL ASPECTS OF THE MINERAL REQUIREMENTS OF FARM ANIMALS.

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THE ultimate purpose of crops grown on the farm is largely the feeding of stock. The successful growing of the former depends to a great extent on the presence in the soil of an abundant supply of these minerals considered to be essential to growth. The well known general principles of manuring are based on an estimation of the amounts of these essential minerals removed by the crop. To maintain fertility there must be a return to the soil of amounts of soil nutrients equal to these taken off in the crop. These considerations, which are recognised in arable farming, are equally applicable in the raising of stock. While turnips, for instance, which is the crop removed in greatest weight from the land, and to which the largest quantities of mineral manures are supplied, contain approximately ·6 per cent. mineral matter, the body of a mature steer may contain as much as 4 to 5 per cent. Therefore, if the necessity for mineral matter can be gauged by the amount required, an adequate supply is as essential in the feeding of stock as in the growing of crops; indeed a deficiency of phosphates or of

lime in the ration of a young fast-growing animal may be attended with just as drastic results as in the case of a crop where such deficiency leads to slow growth, an unhealthy plant, poor bulk and a greater susceptibility to disease.

It is remarkable how little attention this aspect of nutrition has received from investigators, it having been generally considered that the animal is able to get a sufficient supply of all the essential minerals in a reasonably generous and varied ration. The reason for this belief has been that the needs of the mature body are small and that, as the ordinary feeding stuffs contain some or all of the necessary minerals, it was thought that the chance of an animal suffering from a mineral deficiency was slight. There is, however, the well-known exception to this in the case of common salt which has for long been recognised to be essential to good health. Other mineral matter, which it has been customary to supply, has been given more with the idea of providing a tonic or vermifuge than essential nutritive material.

While a great deal of work has been done in investigating the requirements of farm animals as regards the other constituents of feeding stuffs, namely water, proteins, fat, and carbohydrate, little attention has been paid to the fact that, in addition to these four groups of nutrients, there are included under the term "ash" ten or twelve minerals, a certain quantity of each of which is essential to health and growth. The importance of these is shown by the fact that an animal will live longer on complete starvation than when fed on a diet from which minerals are excluded. Much has been done in endeavouring to estimate the quantity of protein required by an animal at the different stages of growth and to express the correct ratio which the protein should bear to the energy and fat-forming part of the ration, but, while this is very important, it is to be noted that, the better balanced a ration is with regard to protein, fat and carbohydrate, the greater is the necessity that the essential minerals should be present in the amounts and proportions required by the animal. The maximum rate of growth on the minimum amount of food is obtained only when the various essential constituents are present in the exact proportions required by the animal so that, if the ration is correct in one respect, the "albuminoid ratio," greater rate of growth is induced with a more rapid breakdown if one or more of the necessary minerals is deficient. This was demonstrated in an experiment at the Rowett Institute where, on a mineral deficient diet, a group of pigs receiving a ration low in protein took longer time to develop "rickets" than another group receiving a ration similar in every respect except that it contained more protein.

When the importance of the mineral elements in the food is appreciated, the question which most interests the practical man is the amounts of these required by the animal. We have little information on this point, except in so far as can be deduced from the composition of the body of the growing animal or of the milk.

Lime and phosphorus are the minerals required in greatest

quantity by the growing animal, because these form by far the greatest part of the dry matter of bone. The body of a store pig contains lime to the extent of about 1 per cent. of its total weight. Thus a growing pig putting on 1½ pounds per day must absorb and retain ¼ ounce of lime per day, and, as not more than half of the lime which it gets in its food is absorbed and retained, the animal would require ½ ounce daily. Similarly it can be estimated that a calf would require an ounce. All commonly used feeding-stuffs contain a certain percentage of lime, so that these amounts are not necessary over and above what is supplied in the ration itself. Potatoes, however, and cereal products are markedly deficient in lime and sodium and probably other minerals, and when such feeding-stuffs are fed to pigs, without the addition of these salts or a food rich in these, the animals are liable to suffer from a disease similar to rickets in children, where softening of the bones and general malnutrition occur. This disease was induced in experiments at the Rowett Institute on a diet deficient in mineral matter, and was also prevented and cured by the addition to the same ration of a lime-rich mixture of salts. The condition produced is one commonly known as "going off their legs," cramp, etc., and is due to a lack of balance in the mineral matter, and has been proved to be analogous to the disease of "rickets" in humans. Of course every pig "off its legs" is not necessarily suffering from a deficiency of minerals. Unfortunately, the pig is susceptible to many diseases which put it "off its legs."

A sow with a litter of ten pigs, each of which is putting on half a pound of live weight per day, must be giving about a gallon of milk daily. Mineral matter is present in sow's milk to the extent of about 1 per cent., so that the sow has to put into her milk over 1½ ounces per day, and for this purpose she must receive in her food at least double that quantity, or rather over 3 ounces a day, of which about 40 per cent. or 1⅛ ounces must be lime. On a ration of equal parts of barley, middlings, and maize, the sow, to obtain this quantity of lime, would require to eat about 150 lbs. daily. It is not surprising, therefore, that on a ration composed entirely of cereals or their by-products, which are all deficient in lime and have an excess of certain other minerals, more especially phosphorus and potassium, sows become lame while suckling, or during pregnancy, when there is also a big demand for the essential mineral elements for the development of the foetus.

The question of the deficiency of iron in the young pig has been studied at the Rowett Institute. Milk is deficient in this element. The young pig is born with a stock of iron in its body, which is presumably intended to supply its needs until it is able to find a further supply in its food, when it begins to eat at about three weeks old. If, during these three weeks the little pig grows so rapidly that it outruns this stock of iron, anæmia with attendant evils may ensue. Death often takes place suddenly, due to dilatation of the heart, before the other symptoms become apparent.

If, however, the mother is carefully fed, so that the milk is good, and the pigs are allowed to run about as in nature and supplement the milk diet according to their instincts, it will be found that they go forward without a check. This disease was produced experimentally at the Rowett Institute on litters of pigs suckling sows, the diet of which during pregnancy and while nursing was deficient in iron. By the application of iron, whenever the symptoms began to appear, the progress of the disease was arrested and the little pigs revived. The condition was most acute in the biggest or fastest growing pigs, because in them the need for iron is greatest. Where growth in big litters was naturally restricted, the mortality was comparatively low.

This question of iron deficiency is undoubtedly a most important one, for it may be that many of the diseases to which young pigs are so susceptible may be due to the lowered vitality and disease-resisting capacity of the animal at this age, in consequence of having been born with an insufficient stock of iron in the body. It seems probable that the success of the open air system of pig-keeping is, to a large extent, due to the fact that, by this method, the little pigs are compelled to take exercise in following the mother about, that iron is always available in the green food which they so eagerly eat, and that the soil itself is a huge storehouse of all the essential minerals. Other things being equal, the more the animal is confined and denied access to this, its natural store of mineral material, the more difficult does it become to rear litters successfully, unless very great regard is paid to the mineral content of the feed. The pig, probably more than any other animal, is liable to suffer from a deficiency of minerals on account of the fact that it is the fastest growing of all the domestic animals and because it is fed mainly on concentrates which are deficient in lime and rich in phosphorus. Growing cattle, if they get concentrates, also get fodder. All fodders are rich in lime and comparatively poor in phosphorus, so that an excess in the one case tends to counteract a deficiency in the other.

Certain feeding-stuffs rich in minerals tend to counteract the deficiencies of cereals and cereal products, on which pigs are largely fed. Fish meal is rich in calcium phosphate, and a small amount would give an ample supply of lime, but it would not necessarily counteract other deficiencies such as a deficiency of iron or excess of acidity or excess of phosphorus. Milk, of course, has the ideal mineral mixture adapted by nature for the purpose of growth, and all milk foods form an excellent supply of mineral matter; but it must be recognised that, to get the full amount of minerals necessary from milk, the whole ration would need to consist of milk, and, therefore, the addition of milk to a ration, though tending to correct deficiencies, does not necessarily readjust the mineral content completely. Green food, rich in lime, sodium and iron, corrects the deficiencies of cereals, hence its great value on the farm.

Even more important than the pig is the question of the dairy cow and its mineral requirements. It is one of the most important in nutrition and experiments in connection with this problem are being conducted at the Rowett Institute. In the general feeding of the cow, the concentrates are usually regarded as the milk-producing part of the ration and the bulky fodder, turnips, etc., as the maintenance part. Now this milk-producing part should in composition be as nearly alike to milk as possible. As far as the mineral part is concerned, there is usually a deficiency of some of the minerals and an excess of others. The greater the disparity between the supply in the food and the demand for the milk, the greater is the drain upon the bones and tissues of the cow to keep up the supply. The result is that a heavily milked, autumn-calved cow is often ready to go on to the grass in the spring time with a skeleton depleted in mineral matter, a weakened constitution, a lowered resistance to disease. It is while she is in this weakened condition, before she is enabled to replenish her diminished store from the fresh young grass, that she is most susceptible to disease. It is possible that feeding has much more to do with the incidence of such infectious diseases as tuberculosis and abortion than is commonly supposed.

It is interesting to note in this connection that, where cows are heavily fed on distillery residue such as draff, wet grains, etc., the custom is to milk them for one year or two at the most, fatten them up for beef and then draft in fresh animals. This procedure is a compulsory one, because it is found that, at the end of one lactation period, the constitution of the cow is so impaired by the feeding, that there is considerable difficulty in getting her in calf again, and also, that she is very often tuberculous. The ration usually fed in such districts consists of turnips, straw, draff and occasionally bran. While it stimulates milk production, this ration is badly balanced as far as mineral matter is concerned, and it is quite conceivable that the evil effects on the cow due to the draff is attributable to this badly balanced mineral content, and not simply to the fact that the cow has been a heavy milker.

Before a cow can produce a large amount of milk and still remain free from disease, she must be bred from a high milking strain, fed when young so as to develop a strong constitution to enable her to resist disease, be a regular breeder of strong healthy calves, and fed when milking and in calf so that her constitution is impaired to as small a degree as possible. The part played by the mineral elements in the feeding of the dairy cow is one which has received remarkably little attention, but from observations already made it would appear as though they played a vital part in the production of the healthy, economic cow and, therefore, of cheap clean milk.

Sheep are less liable to suffer from mineral deficiency than other domestic animals, on account of the fact that the rate of growth is slower and because they are less likely to be confined and not so often fed on artificial diets. The writer, along with

Dr Orr and Captain Elliot, was interested in an investigation into the disease in sheep commonly known as "bent-leg." The disease was produced on a ration deficient in minerals and prevented by the addition to the same ration of a mixture of minerals. It seems, therefore, that mineral deficiency or excess may have an important bearing on research work with sheep.

Young growing horses are seldom forced in growth, so that mineral deficiency seldom arises, but it is a common observation that, while the production of fine, hard bone is essential to the successful rearing of horses, this is associated with certain soils only. It is thought that some relation exists between the nature of the soil and the mineral content of the vegetation and of the drinking water.

To balance a ration correctly, as far as the mineral matter is concerned, does not simply mean the addition of an adequate supply of all the minerals considered to be deficient, for excess may be just as harmful as deficiency. Therefore the salt mixtures which are at present on the market, and which are said to contain all the essential minerals, will not be beneficial in all cases, for they may sometimes be supplying additional salts already in excess, and thus do positive harm. Each individual ration requires to be balanced in itself, according to the requirements of the particular kind of animal, and we are yet very far from knowing the requirements for the different minerals; for these depend to some extent on the amounts and kinds of all the other minerals present, and also on the amounts and kinds present of the essential constituents other than minerals. When further research work is done it may quite well be found that we shall have to alter our view considerably as to the meaning of a balanced ration, for "albuminoid ratio" and "feeding standards" were worked out without reference to the mineral content of the ration, and it is possible that a proper adjustment of the mineral ratio at the various stages of growth may lead to a more economical use of protein and a lower consumption of food to produce a given amount of live weight.

It is remarkable how little attention has been paid to this aspect of nutrition in this country. At the present day, though it is known that mineral deficiencies do exist and have a profound effect on the rate of growth and on the health of stock, we do not know what amounts or proportions of all the different essential minerals are necessary for each class of animal. There is urgent need for much scientific research work, accompanied by feeding experiments on a practical scale, to obtain information of practical value. Until this work is completed it is premature to offer practical advice to stockfeeders with regard to the addition of mineral mixtures to feeding stuffs.

VETERINARY EDUCATION IN SCOTLAND.

ALEX. M'CALLUM, M.A., LL.B.

THE ROYAL (DICK) VETERINARY COLLEGE.

UP to the beginning of the nineteenth century the treatment of diseases and hurts of domestic animals in Scotland was mainly in the hands of cow doctors and farriers with a local reputation, whose knowledge was merely empirical or traditional, and whose methods were often barbarous and sometimes smacked of magic. There were very few veterinary practitioners who could lay claim to any scientific knowledge or training. While schools of training in veterinary science had been established in several European countries sometime before 1800, the London school was not instituted till 1791, and it was for many years the only place in the British Isles where such training could be obtained.

Proposals for a Scottish school were first made about 1793 by James Clark, an Edinburgh practitioner; and again, in 1816, the Lord Provost tried to get the University of Edinburgh to institute a chair of comparative anatomy embracing veterinary physic and surgery. The Senatus of the time, however, apparently did not wish to have associated with the University a veterinary school with the appendages of stables, hospital and forge, and, accordingly, this promising effort came to nothing. It may possibly, however, have influenced the mind of a young farrier--William Dick a native of Edinburgh, and the son of a blacksmith, who soon thereafter began attendance at the lectures of some of the teachers of the famous Edinburgh Medical School, and who was inspired to equip himself as a veterinarian and as a teacher of others. So set was he upon this career that he found means of putting in a three months' session at the London school, where in January 1818 he was awarded the diplôma. Returning to Edinburgh, he made various attempts under different auspices to establish himself as a teacher of veterinary science, and thereby certainly gained some valuable experience. But it was not till he became associated with the Highland Society that his venture came to fruition.

In the spring of 1823 a suggestion was made in a letter to the Society from Mr Robert Johnstone, merchant, Edinburgh, that they should interest themselves in the giving of instruction in veterinary science. The Directors were in sympathy with the proposal, and remitted it for consideration to a special committee, who recommended that the Society's patronage and a grant of £50 be given to a sufficiently qualified lecturer. This was passed by the general meeting in June of the same year, and by November Mr William Dick had been formally appointed lecturer, and he, "furnished with a forge and other appendages for the practical instruction of country farriers, accordingly began his first [*i.e.*, in this connection] course of lectures on the diseases of horses,

black cattle, sheep and other domestic animals, illustrated with the necessary anatomical demonstrations." The first lecture was given in the Calton Convening Rooms [now part of the Corporation Gas Offices in Waterloo Place] on 24th November 1823, and it was attended by several members of the Society's committee and a number of prominent medical men, as well as by twenty-five students, mainly practical farriers, some of whom were from the country. The course was one of forty-six lectures, given on the evenings of Mondays and Thursdays during the session in the Convening Room, though it is not unlikely that some practical demonstrations were given at the lecturer's forge in Clyde Street.

Thus was founded what was known for many years as the Highland Society's Veterinary School, which developed into the Royal (Dick) Veterinary College.

Dick's lectures continued to be well attended, and his appointment as Veterinary Lecturer to the Society was renewed from year to year, the honorarium being finally fixed at twenty-five guineas. The Society, in 1825, at the instance of Dr John Barclay, a noted teacher of anatomy in Edinburgh, took steps to call public attention to the need for veterinary instruction and to the provision made for it at Edinburgh, and suggested to local bodies the advisability of sending from the different country localities capable young farriers to attend the course of instruction with the object of having eventually in each district a well-trained practitioner.

Dick's students had the privilege for many years of attending without fee certain classes in the medical faculty of the University or extra-mural, and also the opportunity of taking classes in such subjects as chemistry or mechanics in the School of Arts, and were thus able to fill out a more complete curriculum than was comprised in the lecture and demonstration course given by Dick himself.

In 1828 a further stage was reached when an examination was held at the end of the session, and a certificate was awarded to those students who showed proficiency in their subjects. The examination was then, and for long after continued to be, entirely oral, and it was conducted by six medical men who testified to the qualifications of the seven successful candidates "to practise the veterinary art." In this session also a forenoon set of lectures was first begun.

The period of attendance was in 1829 extended to two sessions, as "it did not seem upon an average at all reasonable to expect solid acquirements in a shorter time." About this time the teaching was transferred entirely to the premises in Clyde Street, premises which were at first of a somewhat primitive character, but which were gradually extended and improved mainly at Dick's own expense.

In connection with the clinical instruction of his students he provided a stable, in which were housed diseased animals belonging to owners who could not afford to pay for the treatment, and these

animals were kept and treated gratis, with much advantage to the training of the students.

The fame of the school spread, and attracted to it students not only from all parts of Scotland but from England and Ireland, and even from beyond the seas. In 1838 an application made by the Society that students who had gained the certificate of the school should be eligible for veterinary appointments in the Army and in the service of the East India Company, was granted; and in 1840, on a petition from forty-five students, the Board of Directors agreed, and instructed that henceforth the institution should be known as the Veterinary College, and that the lecturer should be entitled Professor.

The institution of the Royal College of Veterinary Surgeons in 1844 raised the question of the right of the Highland Society to conduct examinations for a certificate qualifying to practice. The Royal College wanted to monopolise the issue of such certificates: the Society maintained its rights; and, although for three years, 1845-1848, the Society's examinations were suspended, they were resuscitated in the latter year and independent examinations continued to be held until an agreement was arrived at in 1879, whereby it was arranged that all holders of the Society's certificate should, *ipso facto*, be admitted members of the Royal College, and that from and after 1881 the Society should cease to hold examinations for certification in veterinary science.

One reason for the Society's examination being continued so long in competition with that of the Royal College was that the fees for the latter were too high for the average Edinburgh student, while the Society's fee was kept at a low figure to suit the circumstances, and at the same time the two certificates carried with them equal rights and privileges.

Meantime the attendance at the College was well maintained, and Dick was under the necessity of retaining assistance in the teaching. In 1844-1845 we note that "sixty-one pupils attended, of whom thirty were practical students, fifteen of them being English, one a Russian from St. Petersburg, and the rest Scotch and Irish;" that "the course of study comprehended as usual instruction in the anatomy of the horse, neat cattle, the sheep, the pig and the dog, including also stable management and the forge;" and that "in order to the arrangement of the several departments of study at hours convenient for the students, Professor Dick had the assistance of Messrs John Barlow and William Worthington, who, under his superintendence, took charge of the anatomical demonstrations, materia medica and pharmacy. The necessary instruction in chemistry was given by Dr George Wilson."

The College continued to be conducted on these lines for the next twenty years, the teaching being given in the Clyde Street premises by Professor Dick and assistants, material for clinical demonstrations being obtained from Dick's extensive veterinary practice, while for certain subjects students continued to attend

University or extra-mural classes; and two sets of examinations were maintained, that for the Highland and Agricultural Society's certificate being conducted by veterinary and medical examiners appointed by the Society, and the other for the Royal College certificate conducted by their examining board.

In 1859, Mr Gamgee, one of Professor Dick's staff, set up a rival institution in Drummond Street, Edinburgh, and even obtained a Royal warrant for its recognition as the New Veterinary College. This venture was carried on for several years, but was removed to London in 1865, and after some years was discontinued.

In April 1866 Professor Dick died in the seventy-third year of his age. It is less than justice to say that the Edinburgh Veterinary School owed its rise and development mainly to his personal enthusiasm, energy and determination.

Throughout his career he was greatly helped by his sister Mary, who acted as treasurer and lady superintendent of College affairs from the start till her brother's death. She herself died in 1883.

By his will the whole of Dick's estate was left as an endowment for the College, subject to the liferent of his sister, and the Lord Provost, Magistrates and Town Council of the City of Edinburgh were appointed trustees. Thus a second stage in the history of the College was entered upon, during which its management was in the hands of the Town Council. The connection with the Highland and Agricultural Society was still maintained by the Principal's continuing to hold the office of Professor of Veterinary Surgery to the Society, by the students continuing to sit the examinations for the Society's certificate, and by the Society's continuing the award of class medals to successful students.

Dick's successor as Principal of the College and Professor of Hippopathology was Mr J. H. B. Hallen, who, however, held office for only a year, when he was recalled to India, where he had an important Army veterinary post. He was followed in 1867 by Mr William Williams, who continued in office until 1873. At the time of his appointment a new Chair of Cattle Pathology was instituted by the Highland and Agricultural Society, who promised an annual grant of £100 for five years, on condition that the patronage of the Chair should be vested in the Society. This condition was found to be not in accordance with Dick's bequest to the trustees, and it was therefore modified to the extent that the trustees should make the appointment, subject to the approval of the Society. The grant was continued until 1874 (seven years), and the post was filled in turn by Mr John Adam M'Bride, Mr William E. Duns and Mr Thomas Walley.

During Williams' tenure of office a revision of the curriculum was found necessary: the examination was divided into two—a minor in anatomy, chemistry and botany, held in July, and a final in the remaining subjects in April of the following year.

This led to the introduction first of one summer session and later of a second, so that the period of attendance became virtually two academic years. The teaching of botany was undertaken by Professor Balfour of the University Chair, the Highland Society making a special grant of £50 to meet the expense.

On account of difficulties between the Principal and other members of the staff and between the staff and the students, the Committee of Management thought it advisable in 1873 to ask Principal Williams to resign. Williams promptly set up a rival school in Gayfield House, and christened his venture the New Veterinary College. To this institution the great majority of the students followed him, and for a number of years the Dick College was badly handicapped by the loss of clinical teaching material and of the students' library. This state of matters continued through the brief Principalship of William Fearnley (1873–1874), and for the earlier period of that of Thomas Walley (1874–1894). When Williams left, the attendance at the Dick College was reduced to nine students, but prudent management and able teaching resulted in a large and steady increase in numbers. Indeed, in session 1893–1894 the attendance reached the unprecedented figure of over 300. This, however, was due, at least partly, to the imminence of a further extension of the curriculum, which, during Walley's rule, had been lengthened in 1876 to three sessions, and which in 1895 was fixed at four sessions, with a professional examination at the end of each. As this is the final form of the curriculum up to the present, the list of subjects may with advantage be noted here. They are:—

First Examination.—(1) Anatomy; (2) Chemistry and Elementary Physics; (3) Elementary Zoology and Botany.

Second Examination.—(1) Anatomy; (2) Histology and Physiology; (3) Stable Management and Principles of Shoeing.

Third Examination.—Morbid Anatomy, Pathology and Bacteriology; (2) Materia Medica, Practical Pharmacy, Therapeutics and Toxicology; (3) Veterinary Hygiene and Dietetics.

Fourth Examination.—(1) Principles and Practice of Veterinary Medicine, Meat Inspection; (2) Principles and Practice of Veterinary Surgery and Obstetrics.

Besides rearranging and extending the curriculum in the manner indicated, the Royal College at the same time instituted written examinations. Up to this time examinations had been entirely *viva voce*, but now part of all the examinations began to be taken in writing.

Williams's College was first transferred by him to new premises in Leith Walk, where, after his death, it was continued for a few years under the principalship of his son Owen. In 1904 the latter removed the school to Liverpool, where buildings for housing veterinary science had been gifted by a citizen, and where the school became, and is now maintained as, a department of Liverpool University.

Mention has been made of the death of Miss Mary Dick in

1883. In her trust-disposition and settlement she appointed certain trustees, who were instructed, among other duties, to hold the residue of her whole means and estate with the accumulations of the free income to be derived therefrom, which were to be added thereto until the residue, together with the said accumulated income, should amount to the sum of twenty thousand pounds sterling, but the period of accumulation was not to exceed twenty-one years from the date of her death, and when either of these eventualities arrived, the trustees were to divide the residue and accrued income into two equal moieties, and one moiety thereof they were to apply in the furtherance of veterinary science in connection with the Veterinary College in Clyde Street, Edinburgh, now styled "Dick's Royal Veterinary College," and the other moiety was to be applied in the founding or establishment of a professorship either of comparative anatomy or surgical anatomy (whichever of these chairs her trustees should consider to be most required in the interests of medical science) in the University of Edinburgh in memory of the late Dr John Barclay and the late Professor John Goodsir, declaring that she was led to found this professorship in memory of these gentlemen in respect of the great regard that her late brother entertained for them and that they entertained for him.

The moiety bequeathed to the College under this trust was paid over to the amount of £11,500 in 1907; the other share, about £13,000, was paid to the University, and has been applied to maintain a lectureship in comparative anatomy, held since its institution in 1911 by Professor O. Charnock Bradley, now Principal of the College.

On the death of Principal Walley in 1894 a reorganisation of the College finances and teaching arrangements was carried out, and his successor, Mr J. R. U. Dewar, took office as Principal under the new conditions, the main effect of which was to determine the relation of the teaching staff to veterinary practice and external appointments. With certain exceptions all fees, charges, and emoluments for professional work done by the veterinary members of the staff were paid into a fee fund for behoof of the College, and the shoeing forge and practice previously carried on by a member of staff became the property of the College. From the fee fund the working expenses, salaries, etc., interest on debt, and a sinking fund to reduce debt were drawn, and surpluses, if any, were to be applied partly in making up certain salaries and partly in such ways as the trustees might direct: while, on the other hand, if a deficit should occur, the sinking fund payment was to be suspended and the staff salaries were to be proportionately reduced. The Lord Provost, Magistrates and Council continued to be responsible as trustees for the affairs of the College, but the routine arrangements and the distribution of work and practice were left in the hands of the Principal and the College Council.

While this arrangement worked satisfactorily enough, it was

soon felt that, if the College was to develop and advance with the times, a more drastic reconstruction of policy would have to be considered. The income of the College was insufficient to meet the growing expenditure and an increase of funds was an urgent necessity. After two years of negotiation an agreement was drawn up to which (1) the Lord Provost, Magistrates and Town Council, acting as the trustees of William Dick, (2) the trustees of Mary Dick, (3) the Edinburgh University Court and (4) Alexander Inglis MacCallum, an Edinburgh veterinary surgeon, were parties. The agreement set forth the financial difficulties in which the Town Council found themselves in carrying on the College efficiently; the arrangements made among the parties for obtaining funds from the Mary Dick bequest, from a donation of £15,000 from Mr A. I. MacCallum, and from a grant of £1500 made by the Town Council; and an undertaking by the University Court to promote an ordinance for the institution of degrees in veterinary science, for which degrees attendance at the College classes would qualify *pro tanto*; and finally gave details of the incorporation of the College as a body in which the trust-estate of William Dick, the College moiety of Mary Dick's estate, and the above-mentioned donations would vest.

This agreement was embodied in a Provisional Order promoted by the Town Council under the Private Legislation Procedure (Scotland) Act, 1889, which Order was enacted as the Edinburgh Corporation Act, 1906.

Under this Act and the agreement scheduled therein an Advisory Board was constituted and to it the management of the College affairs was entrusted. On the Board Mr MacCallum was made a life member; two members were to be elected by the Town Council; two by the University Court; one by the Mary Dick trustees during the subsistence of the trust, thereafter by the survivors or survivor of the trustees, and after the death of such survivor by the University Court; three by the registered members of the Royal College of Veterinary Surgeons practising in Scotland (these to be nominated in the first instance by Mr MacCallum); one by the Highland and Agricultural Society; and one each by the three Colleges of Agriculture in Aberdeen, Edinburgh and Glasgow.

The agreement provided for the allocation of the free income of the MacCallum donation to the payment of the salary and class expenses of the Professor of Pathology and Bacteriology, and for the allocation of the free income of the Mary Dick bequest towards the salary and teaching expenses of the Professor of Physiology. A provision was also inserted whereby it was declared permissible for the lecturer on comparative anatomy, appointed by the University Court in terms of Mary Dick's will, to deliver his lectures in the College.

The first meeting of the Board constituted by the above agreement was held within the College Buildings in Clyde Street, on 24th July 1905, when Sir William Turner, Principal of the

University, was appointed chairman, and Mr A. I. MacCallum, vice-chairman. Sir William Turner resigned in 1912 and was succeeded by Professor John Rankine, K.C. On the death of the latter in 1923 Professor Hudson Beare was made chairman of the Board. Mr Robert Anderson, S.S.C., was appointed secretary in 1907 and he was succeeded in 1913 by Mr F. P. Milligan, W.S., who held office till 1923, when a full time secretary was appointed.

Meanwhile in 1911 Principal Dewar had retired and Dr A. Charnock Bradley, Professor of Anatomy and Histology, became Principal.

One of the first cares of the new Board was to consider the future development of the College and the provision of facilities for efficient teaching and research. It was obvious that little could be done with the existing building, which was poorly adapted for modern requirements. In 1830 it apparently consisted of a forge, a hospital, a lecture-room, and a museum. In 1833 a reconstruction, costing some £2500 of Dick's own money, provided improved accommodation in lecture-room, dissecting-room, museum, hospital and forge, and this was practically the state of matters until 1886–7, when the buildings were again extended and rearranged. Now, in 1907, the question of providing necessary laboratories, classrooms, and clinical demonstration premises was seen to be urgent and prolonged consideration was given to the alternatives of reconstruction or removal to a new site. Eventually a property at the east end of the Meadows, Summerhall Brewery, extending to about one and a half acres was purchased in 1911, and plans were instructed for a building to accommodate a maximum attendance of 340 students, with all the necessary adjuncts for teaching, theoretically and practically, the various subjects of the curriculum and for housing animals under treatment. The foundation stone of the new College was laid on 21st July 1914, by the Marquess of Linlithgow, but the final equipment of the building was much delayed by the occurrence of the war and by difficulties of finance. Operations were suspended in 1916, but sufficient accommodation was then available to permit the removal of the teaching from Clyde Street. This was done in two stages—the three junior classes in January and the senior or final in April 1916.

The main buildings are placed round three sides of a quadrangle and provide separate accommodation for anatomy, chemistry, physiology, pathology, biology, materia medica, medicine, surgery, and obstetrics. The fourth side is occupied by the frontage of the hospital buildings which are arranged round a second court yard and contain stables, loose boxes, byres, pens, runs, etc., for the various domestic animals requiring treatment or kept for clinical or research purposes. Prominent features of these new buildings are two relics of the old—the seated statue of William Dick in the main quadrangle and the figure of a horse over the entrance to the hospital yard, both of which were transferred from Clyde Street. The main staircase, itself a gift, is lighted with a stained glass

window presented by former students, in memory of Dick, and the College hall contains portraits of Wm. Dick and A. I. MacCallum.

The Clyde Street premises, after being occupied for some time during and after the war by a unit of the Army Veterinary Corps, were eventually sold in 1920 for £4,500 and have since been converted into a picture house.

The Summerhall buildings were in part also in Government occupation for several years, first by the Ministry of National Service and later by the Board of Agriculture for Scotland. This occupation delayed the completion of the equipment of the rooms, but in the main that has now been overtaken and, although a good deal remains to be done, nevertheless the College is now a handsome addition to the educational edifices of the city with ample accommodation for present day requirements and possible extension. Besides the requirements for actual teaching and demonstration, provision is made for housing research into animal diseases, and under an arrangement recently come to between the Board of Governors and the Animal Diseases Research Association, a suite of rooms and laboratories is to be allocated to research workers employed by the Association.

It will be obvious that the erection of a building of the character described and the extension of the College activities, which it both embodies and makes possible, could not have been brought about without a great deal of forethought and hard work on the part of the Board of Governors. The purchase of the site and the erection of the building involved an expenditure of considerably over £50,000 and the obtaining of so large a sum was no easy task. Fortunately as a result of application to the Secretary for Scotland and the Education Department, the College was recognised in 1909 as a Central Institution, eligible to receive Government grants. More than half of the capital expenditure on the new buildings has accordingly been secured from Government sources, while the remainder was obtained by subscriptions from public bodies and private persons. Mr A. I. MacCallum once again came forward to the aid of the College and contributed £10,500 to the building, and grants were received from the Town Council, £3000; the Highland and Agricultural Society, £400: and the Carnegie Trust, £1000.

Recently the College celebrated the centenary of its foundation, the proceedings including an oration on William Dick pronounced by Sir John M'Fadzean, Principal of the Royal Veterinary College, London; an address on Comparative Pathology by Professor Theobald Smith of Princeton University, U.S.A.; a reception by the Lord Provost and Magistrates in the City Chambers; a Re-union Dinner; and the Principal's "At Home." At the last-named function a portrait of the founder was presented to the College on behalf of Emeritus-Professor MacEachran, Quebec, Canada, a former student.

In connection with the celebrations a three days bazaar was

held in the Music Hall with the object of raising funds to found a Memorial Fellowship in honour of William Dick, whose indomitable spirit will doubtless long continue to influence the institution he established and its successive generations of veterinary students.

THE GLASGOW VETERINARY COLLEGE.

The Glasgow Veterinary College was the creation of James M'Call, a student under Dick at Edinburgh. After obtaining his qualification there he returned to his native county, Ayr, and set up as a veterinary practitioner. His abilities, however, had evidently impressed Dick, who pressed him to return to Edinburgh as a member of the College staff. In this post he remained for two years, and then having gained experience and the impression that there was a career for him in veterinary teaching, he betook himself in 1859 to Glasgow and began to lecture on animal medicine and surgery. Having gathered round him a small staff, he in 1862 opened the Glasgow Veterinary College in premises in Parliamentary Road, and affiliated it with the Royal College of Veterinary Surgeons.

Increasing attendance of students caused him to look for new premises, and these he found in Buccleuch Street, Garnethill. The building acquired had been erected as a reservoir in connection with the City water supply in the days when water was pumped from the River Clyde. After the opening of the Loch Katrine scheme the premises were bought and altered by an omnibus and carriage hirer, and from him Principal M'Call purchased the property and adapted the main portion to the purposes of his College. There the institution was carried on for over thirty years as a private proprietary concern.

There, too, in 1880, as was noted in a previous article of the present series, an attempt was made by Principal M'Call and Mr Primrose M'Connell to establish the "Glasgow Agricultural College" in conjunction with the Veterinary College, but after two sessions the venture came to an untimely end.

The Veterinary College continued to grow steadily, and reached its maximum in number of students in 1894, in which year there was an enrolment of 141. This, however, as was also the case at Edinburgh, was an abnormal figure, the big enrolment being to some extent caused by the notice given that in 1895 the course for qualification under the Royal College of Veterinary Surgeons was to be extended from three to four years. The immediate result of the extension was a drop in the number of entrants. This decrease was emphasised by the establishment at Dublin in the same year, 1895, of the Royal Veterinary College for Ireland, for previously Irish students in considerable numbers came to the Glasgow and Edinburgh Colleges.

This decreased attendance and the consequent loss of revenue caused Principal M'Call in 1901 to make application to the Secretary for Scotland for recognition of the College as an institution eligible to receive grants from Government. The reply

to this request was a reminder that Government grants could not be made to private institutions; but the suggestion was made that the Veterinary College might find it advantageous to combine with the West of Scotland Agricultural College. Negotiations to this end were instituted, but the project fell through.

Pressure of circumstances still continued, and in 1906 Principal M'Call realised that his own advancing years, the imperative need for development, the claims of new subjects for more adequate treatment, and lack of funds were all convincing arguments for reorganisation.

A provisional committee of representative public men was accordingly formed to consider and suggest the procedure necessary to secure a satisfactory reconstitution. At a public meeting held in the Merchants' Hall, Glasgow, and presided over by Lord Provost Bilsland, resolutions were adopted to the effect that steps should be taken to ensure the continuance in Glasgow of facilities for training in veterinary science: that the existing Veterinary College should be established as a public institution under a body of governors: that it should be associated with the University: and that application should be made to the Scottish Education Department for a grant in aid of the purchase of the College premises and an annual grant for maintenance. This public meeting was followed by a representative deputation to Mr Sinclair, then Secretary for Scotland. Figures were submitted showing the attendance of students at the College during the years from 1885-86 to 1905-06. These varied from 141 in 1893-94 to 46 in 1901-02, the average being 90: 60 on the average being Scottish students, 16 Irish, and 14 English. Formal application was made for recognition of the College and for the capital and maintenance grants referred to above, and in support thereof a statement was submitted showing the provision made in the College for the instruction in the different branches of veterinary science. It was stated that the teaching staff comprised lecturers on (1) veterinary medicine, hygiene and dietetics; (2) anatomy; (3) chemistry and toxicology; (4) materia medica and pharmacy; (5) physiology and practical histology; (6) pathology and meat inspection; (7) bacteriology; (8) botany; (9) zoology and parasitology; (10) veterinary surgery and obstetrics.

The Department in reply pointed out that a similar application had been received from the Edinburgh College: that the funds at the disposal of the Department for assisting veterinary education were limited in amount: that it was matter for earnest consideration whether the interests of veterinary science in Scotland and the training of qualified veterinary practitioners would be better secured by devoting any sums which the Treasury might see their way to grant to the maintenance of one well-equipped institution, or by dividing it between two centres. In England and in Ireland only one institution received support from public funds, and it was not to be expected that support on the

same scale could be looked for in the case of two separate institutions in Scotland. The Department accordingly suggested to the Provisional Committee that they should endeavour to discover, by means of a conference or otherwise, what the opinion of County Councils and agricultural representatives in the West might be on the question of maintaining one College or two from a fixed annual sum.

A conference was held in Glasgow on 20th March 1907 and, as might have been expected, it unanimously approved of maintaining the Glasgow College, on the grounds that the wants of veterinary students in the West of Scotland could not be met by one institution in Edinburgh and that Glasgow was the best and most convenient centre for veterinary teaching in the country. Representations in a similar sense were made to the Secretary for Scotland by the Town Council and other public bodies, and a deputation pressed for support of the scheme. The Secretary outlined the difficulties in the way of the Department and suggested that it would be a much stronger case to go before the Treasury if they could say that the scheme had not merely the sympathy but the financial support of the local authorities in the West of Scotland. Appeals were accordingly made to the Town Council, the County Councils in the western area, and other local authorities as well as private individuals, and by June 1908, subscriptions to the amount of £3650 had been received towards the capital fund and £227 had been promised by the Corporation of Glasgow and Western County Councils as yearly revenue. Further representations to the Scottish Office were met with the promise that on a proposed capital expenditure of £10,000 the Government might under the Education Act, if passed, provide half, if the other half could be found locally. By November 1908, the Committee were able to say that the £5000 had been secured, and at the beginning of 1909 formal application was again made to have the College recognised as a Central Institution under the Education (Scotland) Act, 1908. It was then proposed to carry on the work of the College by an Association registered under the Companies Act, 1867, to be licensed as such by the Board of Trade. The amount of capital required to purchase and refit the building was estimated at £10,000 and the annual budget shewed an estimated loss of about £500, of which half was expected to be met by revenue from local grants.

The College was granted a Board of Trade licence as "The Glasgow Veterinary College, Incorporated" on the 20th April 1909, and on the 12th of August of the same year it received recognition as a Central Institution under the Education (Scotland) Act, 1908.

The Board of Governors as appointed under the new constitution contained representatives of the County Councils of Lanark, Ayr, Argyll, Bute and Dumbarton; the Town Council of Glasgow; the West of Scotland Technical College; the Glasgow University Court and Senate; the Faculty of Physicians and Surgeons, Glasgow; the Highland and Agricultural Society; the Glasgow

Agricultural Society; the School Board of Glasgow; and the West of Scotland Agricultural College. The first chairman was Sir Hugh Shaw Stewart, Bart., and the vice-chairman Mr J. Campbell Murray. The property of the College building was acquired as at 15th May 1909 at a purchase price of £9000 and towards this and other capital expenditure a grant of £5000 was made by the Scottish Education Department, Town and County Council grants came to £1450, and private subscriptions amounted to £3633.

The College was thus fairly launched under the new constitution and has since then been carried on under these auspices with varying fortunes. Like other such institutions it suffered during the years of war from both a drop in the number of students and loss of members of staff. Principal M'Call himself died towards the end of 1915, full of years and honour. Several of the staff joined the army, where their services in the Veterinary Corps were of the greatest utility. The attendance of students fell so low as nine in 1916–17 and seven in 1917–18. In 1915 a letter was issued by the Treasury to educational institutions suggesting that in view of the decrease in attendance, the depletion of staffs, and the need for national economy, consideration should be given to the possibilities of amalgamation of institutions, wherever that procedure might appear possible. Following upon that a definite proposal was made that the Glasgow College should be combined with the Dick College in Edinburgh. This proposal was once more strongly and successfully resisted by the Glasgow College, who were soon able to point to somewhat reviving fortunes inasmuch as the attendance of students gradually increased from thirty-three in 1918–19 to seventy-three in 1919–20 and eighty-four in 1920–21.

After Principal M'Call's death in 1916, there was a short interregnum; then in September 1917, Mr S. H. Gaiger was appointed Professor of Pathology, and in the following year he was made Principal.

On the initiative mainly of Mr Peter Reid, representing Argyllshire, where sheep disease annually causes enormous loss to flockowners, application was made in 1915 and later by the Governors of the College to the Board of Agriculture for Scotland for funds to enable the College to institute research into sheep diseases; and in 1918 the Board agreed to expend £1000 in equipping a laboratory in the College for this purpose and also to provide an annual sum towards meeting the salary and expenses of an investigator. Professor Gaiger was appointed to undertake that work, and he carried it on under the direction of the College until in April 1922, he was transferred to the service of the Animal Diseases Research Association, although continuing for some time thereafter to carry out his investigations in the specially furnished laboratory at the College. He was succeeded in office by Mr A. W. Whitehouse who was appointed Professor of Anatomy and Director of Studies in 1922 and was promoted to the Principalship in 1923.

Full particulars of classes and courses with regulations for examination and qualification as veterinary surgeon are contained in the calendars of the respective Colleges and are consequently not detailed here.

THE BIOLOGIST ON THE FARM.—No. XII.

PROFESSOR J. ARTHUR THOMSON, M.A., LL.D.

Birds and Foot-and-Mouth Disease.—It is never premature to inquire, but one must avoid a hasty conclusion. There seems to be no proof that birds can serve as carriers of this calamitous disease, but we suppose it is theoretically possible. *If they do,* it is possible that they might contaminate pasture and feeding-troughs in the fields. *If they do,* the case would be a good example of the intertwining of lives in the web of life. There are many immigrations of birds from the Continent into Britain, especially in autumn; and it is known that when the wave of the disease is high in a country like Holland, there may be soon afterwards an outbreak in England. Some would go further and say that the arrival of great flocks of continental migrants on a particular farm has been followed by an outbreak of foot-and-mouth disease in that area. But one must beware of the *post hoc, propter hoc* fallacy. Many of the charges that have been brought against birds have turned out to be false, so we are inclined to be very cautious when another is raised. It is a question of evidence.

The Smell of the Weasel.—They say that if a dog has had a "set to" with a little troup of weasels, it sometimes smells so vilely that it has to be kept out of the house for days. The odoriferous secretion or stink is well-marked in the weasel, but is usual in related forms. Thus the stoat is also called the "foumart," which means foul marten. The secretion is produced by a patch of glands which lead into a reservoir on each side of the end of the food-canal. A study of these glands—not a fragrant subject—has been recently published by a Japanese physiologist, Kawano, who has got some interesting results. The odoriferous glands are associated with lubricating glands, which open separately on the base of the anal papilla, and some of the latter are transitional between normal sweat glands and the stink glands. In other words, the odoriferous or stink glands are specialisations of commonplace skin glands,—another illustration of a common method in evolution, making a new thing out of something very old, and the specialised out of the generalised.

The glands are surrounded by a capsule of connective tissue and striped muscle, the latter accounting for the forcible discharge of the odoriferous secretion. This reaches an infamous climax in the skunk. The stinking fluid in the reservoir is an oily liquid of a pale glistening golden yellow colour and a heavy appearance. But it is extremely volatile when it is discharged through the

excretory duct which opens on each side at the tip of the anal papilla. The glands are apparently insinkings of the skin of the anal region.

The odour of the fluid in the male of the Japanese Mustela has some resemblance to that of the explosion products of gasolene oil. That of the female is much more offensive and resembles that of methyl-mercaptan, though not so strong in acridity. It would seem that the odoriferous glands have significance in the sex-life of these animals, as well as being important in connection with defence and offence. Thus we see that there is considerable biological interest in the smell of the weasel.

How Flies Pass the Winter.—A correspondent calls attention to the fact that blue-bottles were seen flying about the mouths of rabbit burrows in Aberdeenshire on a frosty day at the end of November. It is probable that they find shelter in the recesses of the burrows where the temperature would be higher than in the open. But one would like to know precisely in what state or states they pass the winter. There are often dead rabbits about the warren; does the life-cycle of the fly sometimes continue? The question has been studied a good deal in Britain in regard to house-flies, but it would be interesting to collect more information from different parts of the country and in regard to various kinds of flies. A recent inquiry in Korea shows that individuals of the house-fly (*Musca domestica*) may spend the winter as adults, and feeding experiments prove that the adult house-fly may live for more than 120 days in winter. The adult house-flies referred to were not torpid, but continued to move actively and to breed. Inquiry into the ways of blow-flies and stable-flies go to show that different species pass the winter in different states,—some as adults, some as pupæ or larvæ.

Wintering.—It is interesting to think of the variety of states in which common animals are spending the winter. The hedgehog is hibernating but the mole is busy underground and the stoat is hunting over the snow. Most of the birds have migrated southwards, but the snow bunting from the north finds our climate quite endurable for winter. Reptiles like adders and slow-worms have sought shelter in the secluded corners, shut off from wind and rain, and they lie in a lethargic state which is akin to the hibernation of the winter-sleepers among mammals and yet different. Frogs and toads are in holes in soft banks or perhaps in a dry drain,—mouth shut, nostrils shut, eyes shut, with the heart beating feebly and respiration going on through the skin. Some fishes swim about slowly below the ice, nosing hungrily here and there, saved by that property of water which secures a higher temperature below than above in the winter season. Most fishes seem very indifferent to cold and the salmon may spawn in mid-winter, which means, however, a slow development of the eggs.

Turning to backboneless animals, we find slugs deep in holes in the ground and the snails far "ben" in the recesses of an old wall. The snails have sealed up the mouth of the shell with a temporary

lid of hardened slime and lime, but their body shows some winter degeneration, and the heart beats very slowly and feebly. Earthworms burrow to a greater depth when the weather is very severe, and thus they get below the grip of the frost's fingers. The young queen humble-bees—the only survivors of the large summer household—are lying quaintly hunched up and deeply hidden in a mossy bank. The queen wasp lies in the thatch or under bark or in some similar shelter. There are winter-moths and winter-midges flying about actively, but most insects are in a state of collapse. Not a few survive as adults, but the majority are lying low as *pupæ* (*e.g.*, the Diamond-back Moth), or as *larvæ* (*e.g.*, the so-called "grubs" of Daddy-long-legs), or as *eggs* (as in the case of the Hop Aphis). It is perhaps absurd to give a single example of each mode of wintering among insects, when there are so many of each. But it is a useful exercise to ask about each of our common farm-animals. How is it wintering?

Disturbance of Adaptation.—Someone brought in the other day one of those extraordinary cases, where the incisor teeth of a rabbit grow in a wrong way with fatal results. We have seen several instances in a few years, so it cannot be uncommon. It is an interesting illustration of a very perfect arrangement going badly wrong. Everyone knows that the incisors of gnawing animals are rootless, which means that a wide communication is left between the cavity of the tooth and the tissues of the gum. This allows abundant food to be brought to the tooth by the blood-vessels, and so they go on growing throughout life. This is an admirable arrangement, for as the tip of the tooth is worn away by gnawing, more tooth is being made at the rootless base.

In ordinary rodents the enamel of the tooth, which is harder than the ivory, is confined to the front, with the result that a chisel edge is formed by the incisors biting against one another. The wear of the enamel is slower than that of the ivory, so a chisel edge *must* be formed. In hares and rabbits the enamel is not confined to the anterior surface of the tooth, but it is more strongly developed in front, and thus a chisel edge is still formed. The hares and rabbits differ from other rodents in having a pair of small upper incisors behind the big ones, and it is against these that the edges of the two lower incisors bite.

This is becoming a long story, but the point is that, if there be some disturbance in the articulation of the lower jaw of such a nature that the lower and upper incisors no longer meet one another with the usual precision, then the teeth will continue growing without being worn away. It then becomes impossible for the creature to gnaw; it may be impossible for it to shut its mouth; eventually the disturbance prevents feeding altogether and the animal dies. The adaptation is so very perfect that a slight dislocation may be fatal. In the babirusa something of the same sort has become normalised. The upper tusks grow upwards!

The Sense of Balance.—There are many different kinds of

animals that have ear-like organs and yet we have no evidence that they can hear. In other cases where the ear-like organs are put out of action, it makes no difference to the sense of hearing, if that is present. What then is the meaning of the ear-like organs found in myriads of backboneless animals? The answer is that they are balancing or equilibrating organs, by means of which their possessors automatically adjust their body so as to keep their balance in swimming, flying, or running, or even their pose when resting. If the organ is injured the animal will often tumble about anyhow or swim on its back. A common type of an ear-like organ is a little bag filled with fluid into which there project the fine hair-like prolongations of sensory cells. Suspended in the fluid there are fine particles of lime secreted by the wall of the sac, or particles of sand and the like introduced from the outside world. These particles jostle against the sensory hairs when the fluid is made to oscillate by movements of the body. Among backboned animals the hearing of the ear becomes more and more pronounced as we ascend the scale, but even in man the balancing function of the ear is still very important.

Hearing in Insects.—When insects make sounds by energetically rubbing one part of the body against another, as is true of grasshoppers and crickets, it is natural to infer that the sounds do not fall on deaf ears. But this is a kind of inference that one is glad to have confirmed by experimental evidence, and it has been proved that female grasshoppers and beetles make locomotor or other responses to the sounds made by the males. In his luminous book on *Entomology* (revised edition, 1923), Professor Folsom notes that "male grasshoppers will answer the counterfeit chirping made with a quill and a file." He also cites Mayer's well-known neat experiments with the male mosquito. The insect was fastened to a microscope slide and various tuning forks were sounded. To some of these the mosquito answered back by sympathetic vibrations of his antennary hairs. This was most marked when the vibrations of the tuning fork were 512 per second, which corresponds approximately to the female's hum. So he doubtless hears *her*. If he adjusts his head, (automatically?) till the two antennæ are equally stimulated, and then flies straight ahead he is likely to find her, if he has any luck.

OX WARBLE FLIES.

DR R. STEWART MACDOUGALL.

THE two Ox Warble Flies (*Hypoderma bovis* and *Hypoderma lineatum*) are well-known enemies of cattle, and the cause of large annual losses to the farmer, the butcher and the leather merchant. For some years a committee, representing the Ministry of Agri-

culture and Fisheries, the Board of Agriculture for Scotland, the Department of Agriculture for Ireland, and the Farming, Meat and Leather Industries of Great Britain and Ireland, has been engaged in an enquiry as to the best means of preventive and remedial treatment in relation to these flies. Much experimental work has been done in the attempt to find a dressing which would act as a deterrent to the flies in egg-laying, and numbers of substances have been tested as dressings for the destruction of the warble maggots in the backs of the cattle. Among the latter tobacco powder and lime proved successful in Professor G. H. Carpenter's experiments in Ireland, and on further trial in Ireland, England and Scotland, the excellent results justified a recommendation in its favour.

It was then decided to have a mass experiment on a County Scale and, through the kindness and willing co-operation of the farmers and stock owners in East Lothian, such an experiment was carried out in East Lothian and neighbourhood in the spring and summer of 1923. Our work in East Lothian had a fourfold purpose:—

1. To test, on a large scale, the tobacco powder and lime dressing in the destruction of *Hypoderma larvæ* in the skin of infested cattle.

2. To try other hitherto non-tested dressings, chiefly Derris and Lethol.

3. To reduce the number of flies in the next season by mass destruction of the larvæ. This third point will be referred to later, but it is convenient to state here that we had not been long at work before it was evident that the annihilative purpose was greatly complicated by the fact—clearly established in the East Lothian enquiry—that the great majority of the cases of warble in the county were not cases of native warble, but that the warbled animals were mostly from regions outside the county, and that next season the new imports of cattle bought for store and feeding purposes would once more bring a fresh supply of warbled animals.

4. To discover whether the mass observations would reveal new points in life-history or distribution of *Hypoderma*, or in mode of procedure.

Some idea of the scale of the work in East Lothian and a part of Berwickshire and Midlothian may be gathered when I say that, after individual dressing of nearly 7000 warble larvæ, these larvæ were pressed out from the infested cattle and each examined to decide whether the larva had been affected by the dressing or not. In addition, farms were visited and many animals examined and reported on, where no warbles were present or where, owing to special circumstances, no examination was possible after dressing or where the farmer or stock owner for reasons of his own, *e.g.*, a cow soon due to calve or fat beasts due in a few days for sale or slaughter, did not desire the animal to be dressed. An attempt was made to visit every owner of stock, but in some cases

the end of the warble season had come before a farm could be reached.

In connection with the organisation work in East Lothian I was greatly indebted to the Board of Agriculture for encouraging help, and to the Edinburgh and East of Scotland College of Agriculture, two of whose staff, Mr Smith, the general organiser for County work, and Mr. Young, organiser for East Lothian, were of the greatest assistance, Mr Young especially going here and there with me and working enthusiastically. For the actual experiments the county was divided into three regions of approximately equal size, each running from north to south, *i.e.*, from the sea (the county is bounded on the N.W. and N.E. by the sea) to the Lammermoor Hills, which form the southern boundary of the county. One of my post-graduate students was put in charge of each of the three divisions, viz.: Thomas C. Cairns, B.Sc., in charge of the eastern division; John N. Oldham, B.Sc., in charge of the middle division; and Thomas Gibson, B.Sc., in charge of the western division. These three colleagues were skilled workers, alive to the problem involved, with an excellent working knowledge of the warble flies and their life history, and trained to accuracy in the actual experimental work and reporting on it. To aid these workers Mr Ian Galloway, B.Sc., M.R.C.V.S., was later added, partly to replace Mr Cairns, who had to leave for South Africa, and partly to take up the work of Mr Gibson, who had to resume University studies in the beginning of May. Mr. Galloway also undertook special experimental work in Berwickshire. I am greatly indebted to these four post-graduate men for their very hard and often not too pleasant work—the squeezing out from the backs of restive cattle is often hard as well as none too pleasing.

Tobacco Powder and Lime Dressing.

This dressing is prepared by mixing 1 lb. of fresh lime in a gallon of water, adding 4 lbs. of the tobacco powder, mixing and allowing to stand for 24 hours, and straining the liquid through muslin or sacking.

This dressing, which had justified itself in the experiments of 1922, has proved in the 1923 work in East Lothian very satisfactory. It has as features:—

(1) a high percentage of larvæ killed.
(2) no ill effects on the cattle either to health or hide.

It was applied not as a wash but individually to each warble, sometimes by syringe, sometimes by a cloth dipped in the dressing, sometimes by a brush, sometimes by a sponge. A comparison as to the effectiveness of each of these methods is given later on. The tobacco powder and lime dressing results are set out in the following table:—

Farm	Applied by	Days between dressing and examination	Number of Warbles dressed	Number of Larvæ killed	Remarks
A 2	Syringe	2	2	2	...
A 7	Brush	2	13	10	...
A 8	"	3	25	19	...
A 13	Syringe	3	28	23	...
D 3	"	3	7	7	...
D 4	Cloth	3	136	109	...
D 16	Syringe	4	104	87	...
D 14	"	3	77	63	...
D 8	Cloth	3	15	12	...
D 18	Syringe	5	23	19	...
H 17	"	2	4	4	...
H 18	"	2	28	28	...
No. 1	Sponge	3	19	16	...
" 2	"	3	36	30	...
" 3	"	5	3	3	...
" 4	"	3	5	3	...
" 5	"	3	12	10	...
" 6	"	3	6	4	...
" 7	Brush	3	6	5	...
" 8	"	5	30	28	...
" 9	"	3	40	23	...
" 10	"	3	38	34	...
" 11	Syringe	3	3	2	...
" 12	Brush	3	28	24	...
" 13	"	3	22	12	...
" 14	"	2	25	19	...
" 15	"	3	24	18	...
" 16	"	3	2	2	...
" 17	"	3	5	3	...
" 18	"	3	16	14	...
" 19	"	3	6	5	...
" 20	"	3	60	46	...
" 21	"	4	17	17	...
" 22	Syringe	4	6	6	...
" 23	Brush	4	33	26	...
" 24	"	3	85	64	...
" 25	"	7	98	76	...
" 26	"	5	14	10	...
" 27	"	5	30	22	...
" 28	"	5	17	13	...
" 29	Syringe	5	4	4	...
" 30	Brush	4	157	123	...
Luffness Mains . .	...	...	181	136	15 of the holes very small.
Ballencrieff Holdings	...	...	19	16	...
Ballencrieff, No. 1 .	...	...	15	14	...
Craigielaw . . .	...	...	135	109	5 holes very small.
Spittal	...	...	160	144	12 holes very small.
Ballencrieft Mains .	...	...	316	265	...
Ballencrieff, No. 30 .	...	...	51	49	...
Dolphingstone . . .	...	...	153	121	Examined 12 days after dressing.
	Carry forward		2339	1899	

Farm	Applied by	Days between dressing and examination	Number of Warbles dressed.	Number of Larvæ killed	Remarks
	Brought forward		2339	1899	
Seton Mains . .	...	...	163	134	...
Redhouse . .	...	...	17	10	...
Bankton . . .	...	...	6	5	...
Tranent Mains .	...	...	9	4	...
Hillhead . . .	...	...	110	92	3 holes very small.
Tranent Dairy . .	...	...	9	9	...
Bridge Street Dairy .	...	...	26	23	...
Hoprig . . .	...	...	104	81	...
Longniddry . .	...	...	262	204	Many holes very small.
Stevenson's Mains .	...	...	137	117	...
Northrig . . .	...	...	151	132	...
Quarrypits . .	...	...	2	2	...
Seggersdean . .	...	..	16	15	...
Coulston Mains .	...	...	27	14	...
Slateford . . .	...	...	8	8	...
Acresdale . .	..	...	26	21	...
Begbie . . .	...	...	21	18	...
Westfield . . .	...	..	10	10	...
Monkrig . . .	...	...	59	48	...
Hopefield . .	..	...	31	31	...
Berberfield . .	...	...	11	11	...
Clerkington . .	...	...	28	28	...
		TOTAL	3572	2916	Percentage killed, 82 %.

One disadvantage of this dressing, which may be stated here, is that the farmer has to handle two different materials, viz.: lime and tobacco powder; it would be advantageous if it were possible for the farmer to use one material only. Further, the tobacco powder and lime mixture deteriorates if kept for any length of time.

DERRIS.

Derris elliptica is a leguminous plant. Preparations from its roots have been in use in the East for long as a poisonous insecticide. Experiments indicate that it may prove valuable not only as a contact, but also as a stomach insecticide. In spring and summer we used a proprietary preparation of Derris.

In testing this material the powder was used in the strength of 1 ounce to a quart of water and 1 ounce to a pint of water.

This dressing had a very fair test, the main work, under my supervision, being carried out by Mr Galloway in Berwickshire, East Lothian and Midlothian.

Mr Galloway's work was very thorough, more careful than that of the average worker would be in ordinary farm practice, inasmuch as any scab and matted hair obscuring the exit hole of the larva in the skin was cleared away before applying the dressing.

Further, a stout syringe was generally used ensuring the entry of the liquid. I was able here to take advantage of Mr Galloway's skill as a veterinary surgeon, for pulse, respiration and temperature were taken before and after dressing, and any consequent symptoms were recorded. No injurious effect attended any of the cattle dressed with Derris, while the Derris dressing proved destructive to *Hypoderma larvæ.* No difficulty was found in applying the dressing, and there was no discomfort to the hands or face of the dresser in case of shaking of the liquid; but Mr Oldham, in some cases which he dressed with Derris, found that, unless care was taken to ensure a thorough mixing of the Derris Powder in the water, the nozzle of the syringe became clogged with powder taken up from the bottom of the receptacle in re-charging the syringe. The following tables give details of the Derris records:—

A.—*One ounce of Derris to a quart of water.*

Farm	Applied by	Days between dressing and examination	Number of Warbles dressed	Number of Larvæ killed
A 14	Syringe	3	26	23
A 1	,,	3	35	32
X 1	,,	3	4	3
X 2	,,	3	14	8
No. 1	Cloth	5	10	6
No. 2	,,	5	5	5
No. 3	,,	5	1	1
Cow No. 57	Syringe	3	4	4
Brunstane	,,	3	21	20
Ecklaw	,,	3	27	26
Branxton	,,	3	19	18
Lawfield	,,	3	31	31
Burnieknowe	,,	3	106	97
Chapelhill	,,	3	96	73
Stoney Path	,,	3	41	31
		TOTAL	440	378
				Percentage killed 86%

B.—*One ounce to a pint of water.*

Farm	Applied by	Days between dressing and examination	Number of Warbles dressed	Number of Larvæ killed
D 7	Syringe	3	32	31
D 10	,,	4	58	55
X 1	,,	3	7	7
	Carry forward		97	93

B.—*One ounce to a pint of water*—Continued.

Farm	Applied by	Days between dressing and examination	Number of Warbles dressed	Number of Larvæ killed
	Brought forward		97	93
X 2	Syringe	3	5	5
Bonnyrigg	"	3	10	9
Cow No. 42	"	3	14	13
Humbie Mains	"	3	29	27
Blegbie	"	3	13	12
Windymains	"	4	17	17
Upper Keith	"	3	10	10
Leaston	"	3	43	42
Brighthouse	"	3	14	14
Highbrae	"	3	4	4
Whitburgh	"	3	49	47
The Cove	"	3	25	21
Home Farm Spott	"	3	88	87
W. Broomhouse	"	3	19	19
Pathhead	"	3	82	78
Ecklaw	"	3	27	26
Longnewton	"	3	8	6
St Martin's House	"	3	20	18
Under Bolton	"	3	40	33
		TOTAL	614	581
				Percentage killed 94

LETHOL.

This is a preparation of tetrachlorethane, regarding which these facts may be noted:— (1) Lethol can be kept indefinitely in suitable conditions; (2) there is no risk of inflammability; (3) the solution is made up just before treatment and should be used at once; (4) it did no harm to the hair or hide; (5) the dressed animals showed no irritation; (6) Lethol itself made face and eyes smart if drops reached them.

On account of so much other work, the number of larvæ treated by this method in the different cases is not large enough to admit of safe generalisation, so that the following record should be taken as more or less preliminary:—

A.—*One part Lethol to 50 of water. Shake thoroughly and a white emulsion results.*

Farm	Applied by	Days between dressing and examination	Number of Warbles dressed	Number of Larvæ killed	Remarks
D 13	Syringe	3	16	5	The lethol is volatile
Cow No. 60	"	5	2	2	Large exit holes
X	Cloth	...	4	2	...
		TOTAL	22	9	

B.—*One part of Lethol in 25 of water.*

Farm	Applied by	Days between dressing and examination	Number of Warbles dressed	Number of Larvæ killed	Remarks
X	Cloth	4	2	1	...
Y	„	4	2	1	...
Z	„	4	2	2	...
D 1	Syringe	5	6	4	...
D 12	„	3	20	13	...
Bonnyrigg . .	„	3	8	5	...
St Martins House .	„	4	9	5	...
Blackburn . .	„	3	26	22	...
Oldcambus . .	„	4	13	13	Large holes chosen
		TOTAL	88	66	Percentage killed 75 %

C.—*Lethol 1 part in 10 of water.*

Farm	Applied by	Days between dressing and examination	Number of Warbles dressed	Number of Larvæ killed	Remarks
Redheugh . .	Syringe	3	11	11	Large holes chosen
Blackburn . .	„	3	11	11	„ „ „
A 9	„	3	17	13	...
St Martins House .	„	5	9	8	...
		TOTAL	48	43	

D.—*Lethol-Nicotine.*

Lethol + 5% of liquid nicotine (90% nicotine). Used in strength 1 of L.-N. to 25 of water.

Farm	Applied by	Days between dressing and examination	Number of Warbles dressed	Number of Larvæ killed	Remarks
Stoney Path . .	Syringe	4	12	8	...
St Martins House .	„	5	6	4	...
Redheugh . .	„	3	6	6	Large holes chosen.
Blackburn . .	„	3	13	13	„ „
D 8	„	3	42	29	...
D 9	„	7	113	80	...
X 4	Cloth	3	9	1	...
Bonnyrigg . .	„	3	10	8	...
		TOTAL	211	149	Percentage killed, 71 %

E.—*Used in strength of 1 L.-N. to 50 of water.*

80 warbles were dressed and 31 larvæ killed = 35·22 per cent.

F.—*Used in strength of 1 L.-N. to 10 of water.*

61 warbles were dressed and 52 larvæ killed = 85·24 per cent.

G.—*Used experimentally as a wash over the back and not as an individual dressing to the warbles, in a strength of 1 L.-N. to 25 of water.*

7 larvæ were killed out of 21.

Methods of Application and Results.

To apply the various dressings one made use of the following:—

(*a*) A stout brass syringe about 6 inches long and with a comparatively blunt nozzle.

(*b*) A cloth dipped in the liquid and then pressed hard on the hide over the hole, a rotary movement being given during the pressure. The twisting movement helped to expose the warble hole and remove any scab resulting from dried exudate, which had formed over the hole.

(*c*) A sponge.

(*d*) A brush.

All the workers found the syringe the surest way, but its use is not favoured by the farmers, partly because it takes more time and perhaps also because it calls for some dexterity in use. It should be pointed out here that the syringe was not a delicate hypodermic syringe with easily breakable needle, but a strong brass instrument.

In using the syringe, the dressing mixture certainly goes further.

Mr Cairns worked almost entirely with the tobacco powder and lime mixture and in the first weeks of his work used a sponge. He found that the continued use of the liquid tended to remove the skin from the finger tips and that constant exposure to the liquid made the fingers painful. The sponge was, therefore, laid aside in favour of a large paint brush and this gave the following results:—

Dressing	Applied by	Number of Warbles dressed	Number of Larvæ killed	Percentage killed
Tobacco Powder and Lime	Sponge	81	66	82·7
" " "	Brush	756	586	77·5

Mr Gibson, in careful comparative work with maggots squeezed out and examined after treatment, found that 70 per cent. were killed when the cloth was used, and 84 per cent. when the syringe was used.

Mr Oldham's experience was that, dressing thoroughly, the syringe took about as long as the cloth, but he found the syringe

surer in the case of comparatively small holes. His comparison is as follows:

Dressing	Applied by	Number of Warbles dressed	Number of Larvæ killed	Percentage killed
Tobacco Powder and Lime	Syringe	273	233	85·34
" " "	Cloth	151	121	90·13
" " "	Brush	38	29	76·31

Mr Galloway, in a special comparative test, found the following:—

Dressing	Applied by	Number of Warbles dressed	Number of Larvæ killed	Percentage killed
Tobacco Powder and Lime	Cloth	457	395	86
" " "	Syringe	70	70	100
Derris	Cloth	128	103	80
"	Syringe	35	32	91

If we analyse carefully the complete recorded results of dressings, considerable variation in the percentage kill will be apparent. The results are variable because:—

1. The holes are often so closed over with matted hair and dried exudate that, unless care be taken to remedy this, the dressing may not reach the larva.
2. Larvæ came to maturity in the back over a period of some months and, on applying a dressing, say on any one day, the holes, according to the varying size of larvæ present on that day, show differences in size, from newly made ones upwards. The hole gradually increases in size from the time of its first indication. A hole, at one time of dressing, may be so small that there is doubt about the entry of the dressing, while the same hole ten days later can be quite conspicuous. Some of the low percentages of kill can be due to very small holes or to accumulation of pus. In the case of very high percentages of kill, care had been taken to remove the scab. It has to be added, that sometimes with the dressing applied with equal care, variations in the kill which could not be explained occurred.

Efficiency of Lime and Tobacco Powder.—No experimental observations as to how long this dressing retains its efficiency have been previously recorded and accordingly, some attention was directed to this point. There is room for still further experiment on a larger scale, but the observations made in 1923 tend to emphasise the use of the freshly made mixture, owing to a gradual loss in efficiency.

On April 4th a quantity of the tobacco powder and lime dressing was made up for experimental purposes. The most badly warbled animal that offered on any date was chosen for treatment.

The material was made up on April 4th and was last used on May 2nd, when it was twenty-eight days old.

Mr Oldham did this experiment and his results were:—

Farm	Date of treatment	Date of examination	Method of application	Warbles treated	Larvæ killed	Percentage killed
D 16	5.4.23	9.4.23	Syringe	23	19	82·60
D 4	6.4.23	10.4.23	"	42	35	83·33
D 8 . .	10.4.23	13.4.23	"	26	19	73·07
D 7	12.4.23	16.4.23	"	10	6	60·00
D 12	17.4.23	20.4.23	"	9	1	11·11
A 7	24.4.23	26.4.23	"	33	1	3·03
H 10	2.5.23	4.5.23	"	10	0	...

One must not lean too much on this table, however, as higher numbers of larvæ must be used. Mr Gibson in his observations found little difference in efficiency up to six days "if the material were kept in a closed receptacle."

Location of Cattle Treated.—A comparison of our results at the end of a week, and still more after a fortnight, indicated strongly that the cases of warble in cattle grazed in East Lothian in spring and summer 1922, were not excessive and that far the greatest number of cattle showing warbles, and, therefore, being dressed, were cattle that had been imported from various places, principally from Ireland, into East Lothian. Permanent East Lothian herds were as a rule very little warbled.

Here is a table, compiled by Mr Gibson, concerning cattle in a part of his area bought from October 1922 into East Lothian and examined by him in Spring 1923.

Location of Cattle in Spring and Summer 1922	Number of Cattle	Free from Warble	Warbled	Number of Warbles
Ireland	494	193	301	1872
East Lothian	328	267	61	236
Cumberland	46	35	11	42
Dumfriesshire . . .	18	5	13	166
Perthshire	8	1	7	131
Lanarkshire	13	6	7	58
Arran	1	0	1	5
Ayrshire	2	2	0	0
West Lothian	1	1	0	0

This table is quoted to show how the majority of the warbled animals in East Lothian have not become warbled in East Lothian, but have walked in, already infected elsewhere. It should be stated that hundreds of larvæ in the hides of animals imported for feeding and sale have not time to mature and fall away from the cattle, and give rise to flies. Before this can happen many of the infested cattle have been sold for slaughter and the larvæ die. In cattle courts, larvæ, that fall away from animals do not reach a

favourable situation for further development and many will be trampled by the cattle.

General Note.—The records given in this report refer to the warbles that were evident on the day of examination. The amount of ground to be covered necessitated the limitation to one dressing and one examination. I am of opinion that, in practice, at least three dressings, and better four, would be necessary in a season. The farmer requires to be convinced that his loss due to warble is anything at all, unless in very bad infestation, and in absence of some kind of proof—and such proof is not easy—that he suffers in pocket, he would be disinclined at a busy time of the year to undertake collecting and dressing in view of the necessary labour involved. The butcher and hide-merchant need no proof of the loss they suffer.

Our experience proved that if dressing ever became general, some erection on the farm would be necessary, into which the animals might be driven for easy examination. Nothing elaborate is required and we are very willing to offer suggestions as to this and, if need be, a drawing.

WART DISEASE.

History, Present Distribution and Control.

THE importation of foreign potatoes into this country has occasioned within recent years many enquiries as to the likelihood of harmful diseases and pests being introduced from abroad. Most potato troubles are widespread throughout the producing countries. It is not likely, therefore, that the incidence of such diseases as blight, ordinary scab, corky scab, rhizoctonia, blackleg and the various virus diseases will be seriously affected by imported foreign material. On the other hand the Colorado Beetle and the Potato Moth have not yet obtained a foothold in Britain. At present, however, both these insects are located in countries, *e.g.*, France, Canada and the United States of America, from which potatoes are seldom, if ever, imported; and, although they may be brought in with other commodities, the danger of their being introduced with potatoes is almost eliminated. Not so is the case with wart disease. Although of all the countries in the world Britain is the one in which wart disease is most widespread, there is still risk of further infection being conveyed to fields in this country by foreign potatoes.

It is, therefore, desirable that potato growers should be fully informed regarding the distribution of wart disease throughout the world, and of the means taken by the various countries to control the spread of the disease.

In the first place, however, it may be of interest to trace briefly the history of the disease from the date of its first discovery.

Origin of the Disease.—While complete tests of all species of Solanum found in South America have not yet been made, it is interesting to note that wart disease has not been known to occur in this continent, which is the natural home of the potato, either on potatoes (*Solanum tuberosum*) or on native species of Solanum which have been specially tested (1).

The first description of wart disease appeared in 1896 from the pen of K. Schilbersky (1), who received diseased tubers from Trentschin, in Upper Hungary, now incorporated in Czecho-Slovakia (2). The characteristic growths caused by the organism are so pronounced that, as this is the first authentic record of the disease, there can be no doubt that the trouble is of comparatively recent European origin, nearly 150 years having elapsed after the introduction of the potato into general cultivation before any mention of the disease was made. In view, however, of the unusual nature of the warty growths, some regard must be given to early, but unwritten, accounts of its occurrence. It is reported to have appeared at Haddington (1) as far back as 1876, a statement which should be accepted with reserve, as at the present day there are no records of outbreaks in that neighbourhood. It may always remain doubtful if the disease had its origin in the region of its first discovery; if the origin must be attributed elsewhere; or whether several unconnected seats of original infection are in question. The solution of these points is rendered all the more difficult by the fact that the original host plants of wart disease (*Synchytrium endobioticum*) are not known; the disease has never been found in nature on any plant but the potato, although in pot experiments (3) it was found on *Solanum Nigrum* and *Solanum dulcamara.* On these two plants the disease was not very pronounced, and might easily have escaped notice had the plants been grown under natural conditions. Some varieties of the tomato are susceptible (14), but all other solanaceous species tested have hitherto remained immune (4). The possibility of the wart pathogen attacking non-solanaceous plants has been investigated in America, but no indication has been found that such extension of the host range takes place.

One authority (1) suggests the possibility of the organism having been partially saprophytic in the earlier stages of its history, and only gradually adapting itself to the potato.

History.—The earliest definite record of the presence of wart disease in Britain appears to be in 1898 (1). One of the first accounts of its appearance in this country is that published by Mr A. Sutton (1898), who stated that he received an affected potato from Dumfries. It is a curious coincidence that the diseased tuber was said to have been grown from seed imported from Hungary, and had come to Dumfries from Birkenhead (1). The variety was "Imperator," now known to be non-immune. It was once commonly believed in Cheshire that the disease was introduced by cattle boats arriving at Birkenhead (1). Dr McDougall, in the *Transactions of the Highland and Agricultural*

Society (1903), states that the trouble was first brought to his notice in 1899 amongst potatoes from Cheshire. M. C. Potter described the disease in 1902, while W. Carruthers (5), in the *Journal of the Royal Agricultural Society, England, 1902*, also gave a description of the trouble, adding that he ascertained that the disease had been known in England for some years prior to that date.

In 1908 wart appeared for the first time in North Ireland (6). In the same year its presence was ascertained in Rhenish Prussia (7), Westphalia (7), and Silesia (2). The disease was probably introduced into these provinces from Hungary. It was reported in 1909 in Newfoundland (8); in 1912 in Schleswig-Holstein and Sweden (2); during the same year its presence was determined in the neighbourhood of the township of Russell, Canada; in 1914 in Norway and Mecklenburg-Schwerin (2) (Germany); in 1915 at Winschoten, Holland, where it appeared to have been known since 1907 (16); in 1916 in N. Bohemia (2); in 1918 in Pennsylvania, where evidence was furnished that the disease had existed for about six years; and during 1919 in West Virginia and Maryland. A communication from the Botanic Gardens, Durban, reports its presence on two farms in the Impendhle Division of Natal.

A factor which must not be ignored in considering the history and distribution of the disease is that certain varieties are immune. It is possible that the disease did not spread much in Britain until the beginning of the century because of the varieties grown. Victoria, Regent, Champion, Magnum Bonum, Maincrop, Abundance and Bruce were all extensively cultivated before the introduction of Up-to-Date (1893) and British Queen (1894). Of these former varieties only one is known to be non-immune, viz., Magnum Bonum (synonymous with Bruce). The probabilities are that Victoria, of which Champion and Maincrop (Langworthy) are natural seedlings, was also immune. There is no doubt, however, that the introduction of the varieties Up-to-Date, British Queen, King Edward, President, and more especially Arran Chief, which are all susceptible to wart disease, has been the cause of the rapid and wide distribution of the trouble. The spread of the disease to districts formerly free from infection must to a certain extent be ascribed also to the disorganisation of the potato industry during the war years.

Present Day Distribution.—The map on p. 77 shows places scheduled as "infected areas" in the British Isles. It must be understood, however, that isolated outbreaks of the disease are found outside these marked areas, which represent only districts in which the disease is most prevalent.

There are no reports to hand of the occurrence of wart in the following countries—France, Spain, Portugal, Soviet Russia, Italy, Greece, Finland, Denmark, South America, Australia and New Zealand. Austria and Hungary in their present much reduced state appear to be free (2). The distribution of the trouble in

South Africa is limited to the two outbreaks already mentioned in Natal. The disease does not occur in Malta nor in the Channel Islands.

America.—The disease has been prevalent for a considerable number of years in Newfoundland and the neighbouring islands of St. Pierre and Miquelon. The Dominion of Canada may now be considered free from the disease; there have been no further outbreaks since 1912, and the Quarantine Order, under which the infected district was placed that year, was removed in 1922. In the United States of America the trouble is confined to gardens in Pennsylvania, West Virginia and Maryland, where the aggregate area of infested land does not exceed 100 acres. No outbreak subsequent to 1919 has been recorded.

Belgium (2).—The disease is stated to have been noticed in the neighbourhood of Ypres during the war.

Germany. (2)—According to the report of the *Biologische Reichsanstalt fur Land und Forstwirtschaft*, regarding the position on the 1st December 1922, Prussia seems to be most severely affected, the disease appearing in the following provinces—Brandenburg, Hanover, Rhenish Prussia, Saxony, Pomerania, Silesia, Schleswig-Holstein and Westphalia. It also occurs in the free cities of Hamburg, Lübeck and Bremen; in Mecklenburg-Schwerin, Mecklenburg-Strelitz, Thuringia, Sachsen-Weimar-Eisenach, Sachsen-Meiningen, Schwarzburg-Sonderhausen and Reusz a L.; as also in the Free State of Saxony and Oldenburg. South Germany is free.

Holland (2).—The disease here is limited to the province Groningen, the principal potato producing area of the country. At present the ground infected consists mainly of allotments cultivated by private persons, but at Nieuw-Weerdinge there are infected plots which belong to small farmers. Only a few cases have been reported since 1920 (16).

Norway (2).—In 1914 the disease appeared in Christiansand, probably introduced from Germany. In 1921 the disease was found 87 miles from Christiansand.

Poland.—By virtue of the inclusion within her boundaries of the previous German territory, Poland is not now free, disease having occurred at one time, according to report (2), in Posen. Apart from that, however, it appears in Upper Silesia (formerly German).

Sweden (2).—In 1912 the disease was found in the island of Ljusterö and in a few gardens in Godermanland, probably introduced with seed from Germany one or two years before. Owing to the energetic steps taken no further outbreaks have since been reported.

Czecho-Slovakia (2).—Here the disease appears in the north boundary of Bohemia.

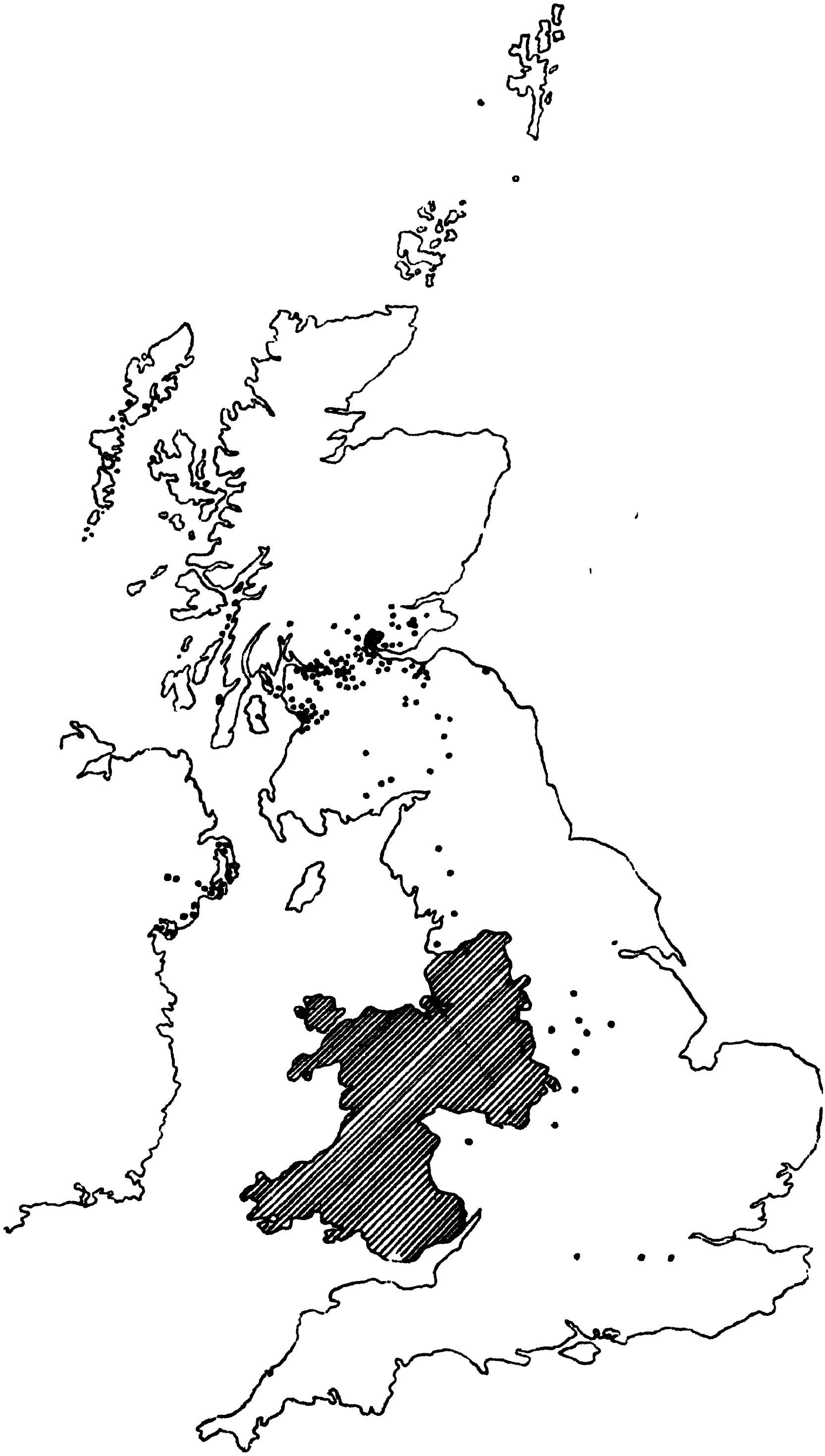
There does not seem to be a distinct geographical limitation to the trouble, although it is less frequently found in warm climates. The type of soil does not appear to be of much

consequence, provided that sufficient moisture is forthcoming; in dry years the disease is much less intense than in wet years. M. C. Potter (9) states that it may be inferred that *Synchytrium endobioticum* is sensitive to a high degree of alkalinity, and fails to attack the potato when the P_H concentration of the soil is in the region of P_H 10·5.

Methods of Spreading.—There is no doubt that the principal means of distributing the disease is the seed. Even when an immune variety is planted the infection can be carried in the earth attached to the tubers. Second in importance is the use of infected manure. Exact experiments are not to hand with regard to cattle, but Malthouse (10) reports that dung from rabbits and pigs which had been fed on warty material still carried spores capable of producing the disease. Towns' refuse, which contains potato skins or material from infected soil, is a common source, as is also the frequent practice by many householders of throwing rubbish, etc., over garden walls into adjoining fields. Implements, cart wheels, birds, drainage water, etc., may also be regarded as carriers. It is a noteworthy fact that most field cases have their location near a gate, *i.e.*, the site of potato pits and most frequent traffic. Not a few outbreaks have been reported of disease being transferred from ploughmen's gardens to farms.

Control.—Seed ought to be obtained from disease-free sources, and dung suspected of being infected should be avoided, as also should the use of towns' refuse in districts where the trouble is known to exist.

The only satisfactory method at present of raising disease-free crops on infected land is the use of immune seed. The question as to whether immunity is absolute or relative has been much discussed. It may be stated that on no occasion has wart appeared in a variety which has been approved by the Agricultural Departments of this country as immune. The occurrence of such phenomena as "wildings" and "bolters" does not affect this statement, as these appear to follow the true varietal type as regards immunity. All investigated reports of immunes "breaking down" have had their origin in the use of impure seed; many susceptible varieties are found as "rogues" in immune stocks, and are morphologically so similar to the immune variety in which they occur, that only an expert can with certainty detect them (*e.g.*, Up-to-Date in Tinwald Perfection, British Queen in King George, Duke of York in Witchhill). A communication received from the *Biologische Reichsanstalt fur Land and Forstwirtschaft*, Germany, states that the varieties Majestic and Abundance, reported upon in 1922 as susceptible, have during this year and with pure seed remained immune. Schaffnit (4) (11) holds that varieties showing immunity under normal conditions may lose this faculty as soon as the plant no longer exhibits its normal form of development or is weakened by constitutional diseases such as leaf roll and mosaic. As, however, the botanical characters of a variety are often completely obscured by virus diseases, it



Map showing distribution of Wart Disease in Great Britain and Ireland.

may be assumed that the plants referred to by Schaffnit, on which wart was found, were "rogues."

In Germany potatoes are described—A. Immune; B. Highly Resistant; and C. Non-immune. That there are degrees of susceptibility is not to be doubted; *e.g.*, British Queen and Sharpe's Victor are not so susceptible as Arran Chief. It is of peculiar interest to note that, while parallel tests of potato varieties carried out at the British Stations and at the United States Station at Freeland are in agreement, the results of tests made at the German Stations do not always correspond with those obtained in this country. Thus Laurus (von Kameke) and Ceres (Cimbal) have been found to be immune in Scotland but susceptible in Germany (12). Ceres is also described as immune by Dutch authorities (16). The following are classified as highly resistant in Germany (12), but have remained immune in Scotland:—Allah (Thiele), Fruheste (Thiele), Helios (v. Kameke), Kaiserniere (Thiele), Kuckuck (Thiele), Marschall Vorwärts (Paulsen), Goldperle (Paulsen), and Ursus (Dolkowski).

In Scotland wart disease usually begins to appear towards the end of August. Some varieties appear capable of resisting the attack for a time, *e.g.*. King Edward and President, while others take it very early, *e.g.*, Up-to-Date, Northern Star and Arran Chief. A disease-free crop can be raised from infected ground in nearly all cases where susceptible early varieties are grown and lifted early.

A point of interest to potato breeders is that, according to Salaman and Lesley (11) (13) and others (15), the character of immunity behaves as a Mendelian factor, being dominant, although orthodox segregation is complicated by various other factors. There seems to be no doubt, however, that in most crosses between two immune varieties the greater percentage of the progeny are immune; the mating of two susceptible varieties usually results in the majority of the offspring being non-immune; while when an immune variety is crossed with one which is susceptible, the resultant seedlings tend to approximate a 50:50 ratio of immunes and susceptibles.

Soil Sterilisation.—The life of the organism in the soil apart from its host may extend to ten years or more. According to one authority (11) the use of immune varieties solves only the immediate problem: "The permanency of this solution is at the present time entirely an open matter, with ultimate probabilities on the negative side." The organism, it is alleged, may adapt itself to immune varieties, in which case a serious position would be created. It is not surprising, therefore, to find that much attention has been devoted to the question of soil sterilisation, but up to the present mostly negative results have been obtained. In Sweden and America successes have been obtained with formalin (2), and formalin combined with steam pressure (14), but the cost of such treatment renders its use unprofitable.

Control within Scotland.—So virulent is the disease that

practically every country in which potatoes are grown extensively has adopted measures to prevent its introduction and spread. The measures taken by the authorities to control the trouble in Scotland are incorporated in "The Wart Disease of Potatoes (Scotland) Order of 1923," by which it is made an offence for any person to plant, or cause or permit to be planted, any non-immune potatoes in any holding not exceeding a half-acre, or any private garden, including farm gardens, or any holding on which disease is known by the occupier to have existed at any time, or to which the provisions of the 1918 Order have been applied, or to which those of the new Order (1923) may be applied. Notification of all outbreaks is compulsory. Except under authority, the sale or purchase or use for planting on clean land of potatoes, grown on land to which the provisions of the Order apply, is forbidden.

Importation into Scotland of potatoes is governed by the three Orders—"English Seed Potatoes, Importation (Scotland) Order, 1920," "The Irish Potatoes Importation (Scotland) Order, 1923," and "The Destructive Insects and Pests (Scotland) Order, 1922." By virtue of these enactments no potatoes can be brought into Scotland from English or Irish "infected areas," while foreign potatoes cannot be landed in this country unless accompanied by a certificate, issued after inspection and not more than fourteen days prior to date of shipment by a duly authorised official, that the tubers have been grown more than 500 yards from the nearest case of wart disease, and that the consignment is free from certain pests, such as Colorado Beetle, Potato Moth and Wart Disease. Where the country of origin does not possess a recognised service of plant inspection, examination of all consignments is made in this country.

Export from Scotland into England.—This is regulated by the "Wart Disease of Potatoes Order of 1923," which imposes the following restrictions :—

1. *Seed Potatoes.*—(*a*) Seed potatoes from crops of immune varieties which have been inspected during the growing season and certified to be of a purity of not less than 99·5 per cent. may be sent to any part of England and Wales.

It should be noted, however, that no potatoes grown on infected land may be sold for planting purposes, except under conditions of a licence granted by the Board.

(*b*) With regard to seed potatoes from crops of (i.) susceptible varieties, and (ii.) immune varieties not certified as to purity, a distinction is made between crops grown outside Scottish "Infected Areas" and crops grown within these areas.

For crops grown outside the "Infected Areas," the certificate will be to the effect that the land on which the potatoes were grown is outwith an "Infected Area," and more than a mile from the nearest case of wart disease.

In the other case, the certificate must show that the potatoes were grown within an "Infected Area" and more than one mile

from the nearest case of wart disease, and the crop from which the potatoes were taken was inspected and no wart disease found.

2. *Ware Potatoes.*—No restriction is placed on the admission into England of Ware potatoes grown in Scotland, except in the case of the non-immune varieties grown on land situated within a Scottish "Infected Area." These cannot be sent to the clean areas in England, unless the importer has received from the seller in Scotland a statement to the effect that the crop from which the potatoes were taken was inspected and no disease found.

Export from Scotland to Ireland,—This is regulated by the Potatoes Importation (Ireland) Order, 1920, by which the landing in Ireland (Northern Ireland and Irish Free State) of any potatoes (either seed or ware) grown in Scotland is prohibited, unless the importer has obtained the necessary licence authorising their entry, and unless the consignment is accompanied by a declaration by the sender on the form prescribed for the purpose, stating:—

(i.) The reference number of a certificate obtained from the Board to the effect that the land on which the potatoes were grown is situated outwith any of the districts declared to be wart disease "Infected Areas," and not less than one mile from any infected land; and,

(ii.) In respect of stocks of the immune varieties, the serial number of the certificate of purity issued by the Board after inspection of the growing crop. Stocks of the immune varieties not certified as to purity are not allowed entry into Ireland, and even certified stocks must have been grown outwith an "Infected Area."

Export from Scotland to other Countries:—1. *America.*—Importation into Canada and United States of potatoes from Europe is prohibited.

2. *Argentine.*—Potatoes for the Argentine Republic must be accompanied by two certificates from the Agricultural Department of the country of origin, one known as the "Sanitary Origin" certificate, stating that the land on which the crop was grown and from which the consignment is taken is clean and free from disease, and another known as a "Sanitary" certificate, stating that the consignment has been inspected and found to be free from disease.

3. *Australia* allows entry of not more than 14 lbs., and only then when the consignment is accompanied by a certificate from a recognised authority. It is necessary, however, that this certificate should state that the consignment is free from a number of diseases, including blight, and as blight is ubiquitous in Scotland, it is in practice impossible to certify any potatoes grown in Scotland as being free from this disease. In actual fact, therefore, potatoes grown in Scotland are debarred from entering Australia.

4. *Austria* imposes no restrictions, but large consignments are liable to examination on arrival.

5. *Belgium.*—A certificate of freedom from Colorado Beetle and statement that wart disease does not exist within 20 kilometers of the place of origin of the potatoes must accompany all potatoes

admitted into Belgium. However, if the disease exists between 5 and 20 kilometers, the consignment must be examined by a Government inspector and certified free from the disease.

6. *Czecho-Slovakia.*—All potatoes admitted to this Republic must be accompanied by two certificates—one stating that no case of wart disease has occurred within 10 kilometers of the place of origin of the potatoes, and another stating that the potatoes have been examined and found to be free from diseases and pests.

7. *Denmark.*—Potatoes are not admitted into Denmark unless they are accompanied by a certificate issued by the Agricultural Department of the country of origin less than a month from date of shipment, stating that the potatoes (i.) were grown in a district free from wart disease, (ii.) have been inspected by the Department and found to be free from wart disease and other injurious potato diseases and insect pests, and (iii.) are contained in new bags, barrels or other receptacles which have been closed with the Department's official seal. In addition, all potatoes landed in Denmark are subject to re-inspection on arrival, with a view to ensuring that the requirements of the regulations are met.

8. *France.*—The regulations governing importation require that the potatoes must not be affected with wart disease. No official certificate to that effect is required to accompany consignments, but the potatoes are liable to inspection at the port of arrival in France. An official certificate of freedom from Phylloxera must accompany all potatoes, etc., landed in France. As this insect pest is not known to exist in Scotland, the necessary certificate can be issued in all cases.

9 *Germany* requires a certificate of freedom from Phylloxera.

10. *Holland.*—Potatoes destined for Holland must be accompanied by an official certificate to the effect that (i.) the potatoes were grown on a farm on which no outbreak of wart disease has occurred; (ii.) no case of wart disease has occurred within 500 metres (approximately 550 yards) of the field on which they were grown. The certificate must also specify the nature of the packing and the distinctive marks thereon. A copy of this certificate must be sent to the consignee before the potatoes are despatched.

11. *Italy* prohibits the importation of potatoes, but provides, in exceptional cases, for the issue of special licences for the admission of seed potatoes.

12. *Norway* forbids importation of potatoes from Britain.

13. *Rhodesia* (*Southern*) requires a certificate that no wart disease has occurred in the district in which the potatoes were grown.

14. *Sweden* does not allow potatoes to be imported from lands in which wart exists.

15. *South Africa.*—Scottish-grown potatoes may, as a general rule, be imported into the Union of South Africa, if accompanied by a certificate that wart disease has never been known to exist within five miles of the place of origin of the potatoes. This

certificate must be obtained within thirty days of the date of shipment. In addition to the official certificate, each consignment must be accompanied by a sworn declaration by the exporter identifying the consignment and setting forth the place of origin of the potatoes.

Recently, however, the Government of South Africa have agreed to a modification of these regulations, whereby potatoes grown within five miles of an outbreak of wart disease may be admitted, provided that they are accompanied by an official certificate stating that (1) no case has occurred on the place of origin of the potatoes; (2) the only outbreaks occurring within five miles of the place of origin are trivial and without menace to lands on which potatoes are grown; and (3) on official inspection the potatoes concerned were found to be apparently free from serious diseases and insect pests.

16. *Uruguay.*—Potatoes must be accompanied by a certificate naming the place of origin and certifying that the potatoes were found on examination by an inspector to be free from serious diseases and insect pests, and that they came from a district free of such diseases. The certificate requires to be endorsed by the Uruguayan Consul.

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LEVELS OF NUTRITION.

DAN. W. STEUART, B.SC.

Introduction.—The surface law of Bergmann and Rubner, that equivalent amounts of energy are consumed for equal surfaces, has been supported by Dubois, Lusk, Armsby, etc. It was originally sustained only for warm-blooded animals which live at a temperature higher than their surroundings; but it has been found, *e.g.*, by Linstedt, to apply also to cold-blooded animals which live at the temperature of their surroundings. The law, then, is more fundamental than was originally assumed. In the feeding of farm animals the law has been applied to signify that, if we know the maintenance requirements, say, of a cow weighing 6 cwts., we can calculate the maintenance requirements of a 12 cwt. cow, not in proportion to their relative weights, but in proportion to their relative surfaces. So if the little cow needs five fodder units daily for maintenance, the big one needs not ten fodder units, but only eight.

$$\text{Thus, } 5 \times \left(\frac{12}{6}\right)^{\frac{2}{3}} = 8.$$

In this paper an attempt is made to interpret the results of some typical feeding experiments in terms of surface, and the results of the general survey are interesting,

I. **Swedish Pig Fattening Experiments.**—Report No. 246 of the Swedish Agricultural Experiment Station summarises the results of over 100 pig feeding experiments covering the period from 1908 to 1922. The results are summarised in the following table:—

Weight. Class.	Number of Experiments.	Average weight in lbs.	Fodder units per head per day.	Daily gain. Lbs.	Fodder units per 1 lb. gain.	Surface in sq. metres.	Fodder units per sq. metre per day.
1	2	39·7	2·38	·76	3·15	·60	3·99
2	7	56·4	2·84	·81	3·52	·76	3·76
3	16	79·2	3·68	·99	3·86	·95	3·89
4	29	99·2	4·30	1·09	4·00	1·10	3·91
5	38	121·5	5·03	1·21	4·24	1·26	3·90
6	43	144·4	5·71	1·32	4·37	1·41	4·04
7	31	164·3	6·18	1·39	4·49	1·54	4·01
8	45	190·7	6·73	1·44	4·73	1·70	3·95
9	21	206·4	6·99	1·41	4·95	1·79	3·90
10	2	253·6	7·59	1·54	4·92	2·06	3·69
						Average	3·90

From these results it is immediately apparent that these fattening pigs have been feeding pretty uniformly at the rate of 3·9 fodder units per square metre of surface daily. If we wish to base a feeding standard for fattening pigs on the results of these experiments, the most sensible way to do it, apparently, would be

to allow the pigs of all ages 3·9 fodder units per unit of surface. Thus we get the following figures :—

Feeding Standards for Fattening Pigs.

Live-weight. Lbs.	Fodder units per head per day.	Live-weight. Lbs.	Fodder units per head per day.
40 (30-50)	2·34	160 (150-170)	5·90
60 (50-70)	3·07	180 (170-190)	6·39
80 (70-90)	3·72	200 (190-210)	6·85
100 (90-110)	4·32	220 (210-230)	7·30
120 (110-130)	4·87	240 (230-250)	7·74
140 (130-150)	5·40	260 (250-270)	8·16

These feeding standards agree excellently with Kellner's for fattening pigs. Kellner's feeding standards for growing pigs, intended for breeding, work out at 3.14 fodder units per unit of surface, so that the level of feeding in this case is 20 per cent. lower than the fattening level. The maintenance level for pigs is probably about 1·37 fodder units per unit of surface; at any rate Hansson reckons that 35 per cent. of the food used by his fattening pigs was required for maintenance purposes. (It appears to vary from 1·0 to 1·5 with the temperature, being higher in winter than in summer.) Feeding standards for pigs were given in this *Journal*, April 1921, p. 155, *et seq.*

II. **British Bullock Fattening Experiments.**—In 1909, Ingle published a summary of British bullock feeding experiments in the *Transactions of the Highland Society*, Wilson made use of these in a paper, "The Application of the Fodder Unit System of Feeding to the Fattening of Cattle," read before the Royal Dublin Society in February 1920. The results of this study are summarised below :—

Weight Class.	Number of Experiments.	Average weight in cwts.	Fodder units per head per day.	Daily gain. Lbs.	Fodder units per 1 lb. gain.	Surface in sq. metres.	Fodder units per sq. metre per day.
1	5	6	11·85	1·80	6·1	4·39	2·70
2	11	7	14·58	1·86	7·8	4·87	3·00
3	11	8	15·92	1·79	8·9	5·32	2·99
4	36	9	17·53	1·59	11·1	5·76	3·05
5	8	10	21·05	1·93	10·9	6·18	3·41
6	20	11	18·69	1·82	10·3	6·58	2·84
7	23	12	19·80	2·02	9·8	6·97	2·84
						Average	2·98

In this case the bullocks have been feeding pretty uniformly at the rate of three fodder units per square metre of surface daily. A feeding standard based on this allowance can readily be calculated from the figures shown above. It would not agree badly with Armsby's feeding standard for fattening cattle. The maintenance

requirements of store cattle lie about 1·2 fodder units per unit of surface (varying from 1·0 to 1·4, depending on the previous rate of growth); but with fat cattle it rises to between 1·8 and 2.3. As only the food supplied in excess of maintenance is available for producing fattening increase, there is something to be said for shorter and more intense fattening periods, although this would entail the use of a greater proportion of concentrates in the ration. The Kellner and Hansson feeding standards for fattening cattle work out at between 3·3 and 4·0 fodder units per unit of surface, say 3·7; or 2 fodder units per 100 lb. live-weight per day. The results of Scandinavian bullock fattening experiments reported by Nanneson agree pretty well with the British experiments, in that it required from eight to eleven fodder units to produce 1 lb. of gain. The following figures of his referring to thirty-three fattening bullocks are worth quoting:—

Period.	Days.	Gain per head per day—lbs.
I. . . .	15	5·3
II. . . .	33	2·4
III. . . .	80	1·5
Total . . .	128	Average 2·2

Kellner's level of feeding for growing dairy cattle works out at from 2·5 to 2·2 fodder units per unit of surface daily; but for beef breeds, 3·0 to 2·5. He makes the level diminish as the animals grow older. Feeding standards for cattle were given in this *Journal*, October 1920, p. 433, *et seq.*

III. **British Sheep Feeding Experiments.**—In 1910, Ingle published a summary of British sheep feeding experiments, which Wilson adapted to the fodder unit method of rationing in his book, *The Breeding and Feeding of Farm Stock*, published by Methuen in 1921. The results are summarised below:—

Weight Class.	Number of Experiments.	Average weight. Lbs.	Fodder units per head per 7 days.	Lbs. gain in period.	Fodder units per 1 lb. gain.	Surface in sq. metres.	Fodder units per sq. metre per day.
1	22	70	12·70	1·30	9·8	1·00	1·81
2	13	90	15·92	2·04	7·8	1·19	1·92
3	39	110	16·65	2·17	7·7	1·36	1·76
4	43	130	18·17	2·26	8·0	1·52	1·71
5	7	150	22·57	2·93	7·7	1·67	1·94
6	5	170	28·29	2·58	11·0	1·81	2·23
						Average	1·89

These sheep were all fed at the approximate rate of 1·9 fodder units per square metre of surface daily. The Kellner and Hansson feeding standards for fattening sheep and lambs work out at 1·72 fodder units per unit of surface, or 2 fodder units per 100 lb. live-weight per day. The maintenance level for sheep is about ·8 to 1·1 fodder units daily per unit of surface. Temperature and

thickness of fleece seem to have little effect. Kellner's feeding standards for growing sheep vary from 1·68 to 1·09, average 1·38, fodder units per square metre of surface daily. He makes the level here again diminish as the animals get older. Feeding standards for ewes were given in this *Journal*, January 1923, p. 88.

IV. **British Poultry Fattening Experiments.**—Paynter's Farne Islands' experiment carried out in 1907, described in his book, *Method of Poultry Rearing*, published by *Country Life*, dealt with the fattening of Buff Orpingtons up to an age of twenty weeks. The results are summarised below:—

Age class, Months.	Average Weight. Ozs.	Ozs. Food per head per 28 days.	Ozs. gain in period.	Lbs. Food per 1 lb. gain.	Surface in sq. metres.	Lbs. Food per sq. metre per day.
1	4·0	18	6·63	2·71	·024	1·58
2	16·8	55	18·00	3·06	·063	1·93
3	40·3	91	25·94	3·51	·114	1·80
4	59·1	120	17·25	6·96	·147	1·81
5	76·6	142	15·81	8·98	·175	1·81
					Average	1·79

These fattening chickens have been feeding fairly uniformly at the rate of 1·8 lbs. of grain and meal per square metre of surface per day. The eighty-fourth Report of the Royal Agricultural College of Copenhagen dealt with the rearing of Buff Orpingtons in 1910 and 1911. After the first three weeks these birds, on a grass run, fed very uniformly at the rate of 1·52 lbs. of food supplied per square metre. The estimate of the maintenance requirements of fowls given in this *Journal*, April 1922, p. 157, *et seq.*, was 1 fodder unit per square metre of surface daily.

Conclusion.—The food requirements of fattening animals of the same kind are proportional to their surfaces. The level of nutrition for growing animals is intermediate between the maintenance level and the fattening level. It may be, also, that animals *prefer* to live at a constant level of nutrition as far as possible. (The plane of feeding for a female animal in full lactation approximates to that of a full fattening ration).

INTESTINAL ROUND WORMS OF SCOTTISH SHEEP.

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In addition to Hook-worms and Stomach-worms, sheep are the hosts of a number of smaller forms, some of which undoubtedly cause some degree of disease. Most of these belong to the same family as the Stomach-worm, the family *Trichostrongylidae*, so

called from their thread-like appearance. All of these worms are small slender forms with no mouth-capsule (as in the Hook-worm) and no teeth (as in the Stomach-worm). They resemble these forms, however, in the possession of a bursa in the male, in the shape of the eggs, and so on.

The most important of these belong to the genus *Nematodirus*. Two very closely related species are found in Scotland, *N. filicollis* and *N. spathiger*. These two species are separated by very minute differences in the male—differences which can only be seen under the microscope.

The worms are found in tangled hair-like masses or singly, in the small intestine—often in enormous numbers. When fresh, they are sometimes of a pinkish tinge, indicating that in all probability they are blood-suckers. However, they have never been found adhering to the intestinal wall, even when this has been examined while still warm.

The female worm (Fig. 1) is about one inch long. The

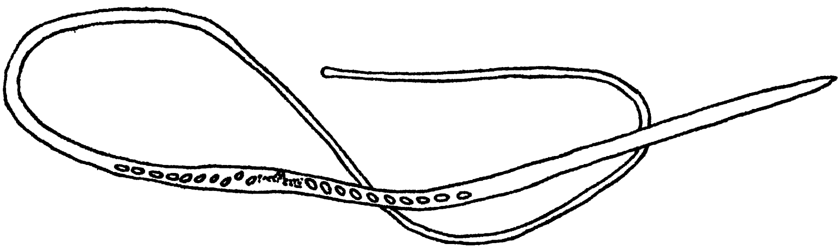

FIG. 1.—*Nematodirus*—female. Magnified.

anterior portion of the parasite is very slender—more so than the posterior portion. The genital opening is conspicuous even under a hand-lens. The male is smaller than the female (½ to ¾ inches) and is not divided into two distinct regions. At the hind end is a small bursa, which is divided into two separate lobes, without the small eccentric lobule seen in the Stomach-worm (Fig. 2).

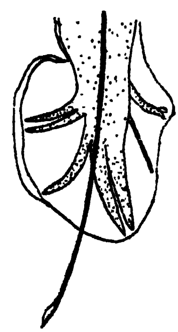

FIG. 2.—*Nematodirus*—bursa of male, greatly enlarged.

The females lay relatively large eggs, which pass on to the grass with the droppings. A small larva develops in the egg and, before hatching, moults twice. On the second occasion, however, it remains inside its old skin. At temperatures under 75° the larva remains inside the egg, but if the temperature rises above 75° it hatches, and, climbing up a blade of grass, waits until it is swallowed by a sheep. It will remain thus for nearly a year, without losing its power to infect the sheep. When it is swallowed, it casts its old skin and ultimately develops into an adult worm.

The damage done to the sheep by these worms is not well

known. When present in large numbers, they have been considered to cause malnutrition and consequently poorness of condition. The writer has found them, however, in large numbers in fat lambs. Much more information is required about their habits in the sheep. If these worms are responsible for any damage, it will probably be shewn by poorness of condition and general unthriftiness.

Prevention is on similar lines to that recommended for Stomach-worm, but in this case we know of no really satisfactory drug for the treatment of the disease. This parasite has been found in cattle and goats as well as sheep.

In addition to *Nematodirus*, a number of closely allied, but even smaller worms are found in sheep in Scotland. The most frequent of these is a very small form always found with its head coiled on itself called *Cooperia curticei*. It is probably of little or no economic importance; but it is of interest, as this is the only record of it occurring in Europe. It is also found in cattle.

Another small round worm found in sheep, but belonging to an entirely different family, is *Trichuris ovis*, the sheep Whip-worm. This worm is characterised by the possession of a long slender neck, which is usually found threaded through the mucous-membrane of the caecum—the blind sac of the large intestine. The posterior region in both sexes is very much swollen, but while in the female this is straight, in the male it is coiled on itself. There is no bursa and no mouth capsule. Both sexes are about two to three inches long.

Most sheep harbour a few of these parasites. Surrounding each worm, which is partly embedded in the wall of the intestine, is a small inflamed area. No well defined clinical symptoms have been traced to this parasite, but there can be no doubt that, when the worms are numerous, considerable damage is done to the host. Bacteria also may enter through the tunnel made by the worm. Here again, however, more information is required.

The life history of this worm is unknown, but it probably is direct. That is to say, the egg, passed out in the fæces, develops an embryo and is swallowed by a sheep, the larvæ completing their development in the sheep

No satisfactory treatment for these parasites is known, as their position in the wall of the large intestine renders all ordinary drugs useless.

Notes on Ensilage.

THE following notes deal with the different methods of growing and stacking ensilage crops on several farms in Argyllshire:—

Islay Home Farm, Islay.

In this part of the country it has been, in the last two years at least, a matter of considerable difficulty to secure good hay and harvest good crops for winter food; but ensilage crops have been grown on this farm for some years and good results have attended this method of obtaining winter food.

Unfortunately the 1923 ensilage crop was entirely destroyed by rabbits, and the following notes refer to the crop of the previous year. The mixture sown consisted of Hamilton oats 1 bushel; barley 1 bushel; rye 1 bushel; tares 1 bushel; and peas 1 bushel per acre. About the 20th April this mixture was sown broadcast on ploughed land, harrowed in and rolled. Five cwts. superphosphate was given alone—no dressing of farm yard manure being given to this crop. The ensilage crop followed a white crop, the rotation being white crop—ensilage—white crop—seeds. The 1922 crop was a good one, standing up well and not lodged in spite of the wet summer of that year.

Cutting took place about the 12th of August, an ordinary mower being used for the operation. This mixture has been found to grow very closely and quite successfully smother any weeds. After cutting the crop, which is done when the grain is at the "milky stage," it was collected into windrows and left for one day to dry. The aftermath was good and was used for sheep grazing, as the second crop was too thin to be worth securing.

It is not possible to estimate the value of the crop aftermath as a green manure, as the following crop, an ensilage crop, has been destroyed by rabbits.

Stacking.—All growers and makers of ensilage are unanimous as to the importance of the stacking of the cut crop. The stack made at this farm is a round one with a diameter of 12 feet and built with a straight leg to a height of from 12 to 14 feet. The stack is then headed off and, to minimise waste, the sides are well plucked by hand and made as firm as possible. Heating then takes place and the temperature is allowed to attain a degree of 180 Fah. Beyond this point no rise in temperature is allowed, and to prevent a further rise pressure is applied by means of a covering of earth of an average thickness of 6 inches. If further heating takes place, more earth is put on, until no further rise in temperature is recorded, and when the temperature has sunk to 120 Fah., no more pressure is applied. To make the earth covering more secure a ring of turf is placed round the "easing," turf side down. Cracks which may occur later in the earth covering are filled up and beaten smooth with spades. Silage stacks on this farm have been earthed all round, but this practice has not been found to be of any great advantage in preventing side waste. The stack is cut in the same manner as a tart with a hay knife, the earth covering the portion required for immediate consumption only being removed.

Feeding.—Old meadow hay of good quality and cut green was mixed with the silage crop before stacking, about a quarter of the total bulk being meadow hay. The first ensilage was used on the 5th December and from the first day was eagerly eaten by the stock.

Silage v. *Roots.*—Two lots of four cattle each were taken, each lot being "evened up" as far as possible. The experiment commenced on the 5th December, when the cattle, weighing at the time 6¼ cwts. each and eighteen months old, were in courts.

One lot got a daily ration of 40 lbs. ensilage and an unlimited supply of straw, the other lot receiving 40 lbs. of roots and an unlimited supply of straw. This feeding was continued till the end of

March, when both lots were put out to grass. The two lots grazed together all summer, and when seen on the 24th October would average about 9 cwts. each. The four cattle which were wintered on ensilage and straw were looking fully as well as the four which were wintered on roots and straw. (No actual weighings available).

It was noticed, when the cattle were first put out to the grass, that the ensilage wintered cattle were drier in the coat than the other lot, but this condition was soon corrected by the change of feeding. In this district it is a belief that animals wintered on an ensilage ration do not "summer" well, but this opinion was not borne out by the result of this experiment.

Yields.—The average yield of turnips on this farm is 20 tons per acre and the yield of silage in the green state is estimated at from 17 to 20 tons per acre, giving from 8 to 10 tons of ensilage. One acre yielding 20 tons green silage has been found to keep 2½ cattle feeding for six months. No wastage takes place except round the sides of the stack.

General.—The manager of the farm is convinced that this system of making ensilage should be made much more use of in this district, where harvesting is such a problem and usually a very much protracted operation ; he is also of the opinion that the root acreage can, by the growing of these green crops, be reduced by 50 per cent. By the adoption of such a system as is practised on this farm, hay could be cut green, secured at once and made into ensilage, instead of being left to blacken and rot in the fields in the endeavour to get it into fit condition for stacking as hay.

Jura Home Farm.

No special silage crop is grown here, old meadow grass which is well mixed with clover being cut before it is ripe, about the second week in July, and stacked immediately. On the poor class of soil on this farm, special silage crops would not grow thick enough to smother weeds. In this case the cut grass is not gathered into windrows, but is built straight away into the stack.

Stacking.—The stack is a circular one about 15 feet in diameter and about 14 feet high when settled. It will be understood that this type of silage crop builds quite solidly and does not settle much in the stack. The stack should be well built, straight in the leg and even taken in a little at the easing. The crop should be forked up all round and not thrown up on one side only, so as to ensure uniform packing and even settling in the stack. A small trench is dug round the foot of the stack to drain away the exuded liquid. Any waste material (rushes, bracken, etc.) are used to bottom the stack. When headed off, the crown of the stack is about 3 feet above the easing. A layer of rushes is used to thatch the stack and, above this, heather sods are laid tile fashion, heather side down, so that the rush thatch is thoroughly covered. Round the easing specially long cut sods are laid and allowed to come well down over the easing. As these sods are apt to slip down, a wooden stake is usually driven through each sod into the stack to hold it in position.

It is calculated that on a stack of this size the covering of

rushes and sods weighs about one ton. The stacking and covering operations follow each other closely, and on the day after stacking the sides are plucked as close as possible. About 6 to 8 inches of ensilage round the sides is usually wasted.

This year (1923) cutting has been done on a face, as it is believed this exposes less surface and reduces wastage. Some silage, which was left over from last year and preserved through the summer, was examined and found to be in excellent order—it was being fed to horses, sheep and cattle and very much relished by them. To preserve this material a turf wall about 18 inches thick was built up the face of the stack, which had been opened and cut in the winter of 1922–23, at a distance of 10 inches from the stack face; this space was filled up with earth; and the wall was built right up to the top of the stack. The material which was being removed and used on 25th October 1923 was quite warm and fresh. Boards and props were used to support the unused portion of the stack.

Feeding.—Silage is fed at Jura to horses, sheep and cattle regularly and has always been readily eaten. Cattle get a daily ration of 40 lbs., but no straw, and it has been found that this ration does not unfavourably affect the summering of stock. Cattle have even been found to summer and winter better on this food than on roots. About the end of February cattle fed on silage alone have been found to lose weight slightly, but on adding a little hay or straw to the ration they have at once regained weight. Milch cows have been fed on ensilage and no tainting of milk has resulted, except where milk has been carelessly left in open pails near loose silage in the byres. Tup hoggs are wintered-in on silage and do well. Horses all get it and relish it.

General.—It is considered that the stack method of making ensilage is most useful in this district. The small farmers can use it and no material outlay is necessary. Crops can be used which in bad seasons are very often wasted. The stack can be built anywhere to facilitate handling. As the turnip crop on Jura is a very expensive one to grow and in seasons like 1922–23 it is almost impossible to get a crop at all, it is intended to replace the whole of the turnip crop with silage.

Dunmore, Tarbert, Loch Fyne.

A special mixture is sown here consisting of Hamilton Oats 10 lbs., Scotch Rye 56 lbs., Winter Tares 56 lbs. per acre. A full description of the treatment of the crop and the method of stacking appeared in the October 1922 issue of the *Journal.*

Feeding.—40 lbs. per day ensilage is the usual ration and as much straw as the animals can eat. If enough silage could be produced, the animals would get as much as they could eat. At Dunmore, ensilage has only been fed to cattle and, if an animal does not eat it to begin with, it has been found that, if offered no other food, the ensilage is generally eaten up in twelve to eighteen hours. It has been the experience of the occupier of this farm that silage-wintered cattle invariably stand a journey much better than those fed on roots and do not lose so much weight between farm

and market ring. Silage has been fed to cows and no tainting of milk has occurred.

General.—No roots are now grown at Dunmore, these being entirely displaced by ensilage. After the crop is cut, the produce of 2 acres can be harvested by three men in one day—(one man and cart—forker—builder on stack). At Dunmore it is estimated that the produce of 1 acre would keep an animal for six or seven months. The proprietor is convinced that in this district, where the risk of harvesting is so great and the cost of preparing turnip land and subsequent tillage is considerable, bulky green crops must be grown and made into ensilage. One good grain harvest every five years is all that he reckons on getting at Dunmore.

Rerrick Park, Dundrennan, Castle Douglas.

Sunflower Experiment.—Sunflower was the crop used on this farm for ensilage. The sunflower seed was sown alone by means of a turnip-seeding machine on ridges as for turnips, and was thinned to a 1 inch to 18 inch plant interval. Summer cultivation was given as for a turnip crop. The crop was found to be a hardy one and grew to an average height of 7 feet. Cutting was done by means of bill hooks and the cut crop was tied up in bundles or sheaves, then chaffed and blown into the silo. Rats did a lot of damage to the crop in the young tender stage by eating the young plants round the edges of the field. The proprietor states that the growing of this crop curtails a lot of work and that it is only worth growing on good land which is in the best of condition.

Feeding.—The sunflower ensilage was fed to dairy cows at the rate of 30 lbs. daily, commencing at about the New Year. There was no effect on the milk yield, but it was thought that the milk soured more quickly when the cows were on this ration. Difficulty was experienced in obtaining good class cheese, but double cooling before the milk was put into the vat thoroughly corrected this condition.

Oats.—The crop now grown for ensilage is oats, sown on ground which has been well manured with F. Y. M. and artificials. The crop is grown in a 25 acre field, of which 5 acres are in turnips. The crop is grown in this field each year, the turnip brake being rotated over the field and a seeding of 5 bushels per acre is given. The crop is cut just when it shows signs of going down in the straw, usually about the end of July or beginning of August. The cut crop is allowed to lie for two days to dry. An average crop at Rerrick Park is from 12 to 14 tons per acre. The aftermath is useless for grazing purposes, as no seeds are sown out with the oats and the stubble is ploughed early and allowed to lie as a bastard fallow. No second crop is taken.

Feeding.—The ensilage makes excellent food, a ration of 30 lbs. plus a basket full of turnips being usually given daily. The stock eat the silage readily. If cows are getting a good ration of roots, meals, etc., the experience here is that a higher yield of milk is got than when feeding on ensilage alone; but ensilage plus a few roots or potatoes gives as good a milk yield as a root and meal ration.

Silo.—The crop is stacked in a wooden silo, 36 feet high and 16 feet in diameter, which has a holding capacity of 170 tons. The chaffer and blower are driven by a Fordson tractor.

General.—The crop sown might be improved by first sowing beans on the rough land, harrowing in and, when the beans have got a start, broadcasting the oats. More leguminous crops (peas, tares, etc.), might be included in the mixture.

Scottish Fur Farming.

SINCE December 1920, a new and successful live stock venture has been carried on at Alness, Ross-shire, where a Scottish Company, the Snow Belt Farms Ltd., has established a fox farm. This farm, which stands 800 feet above sea-level, consists of 50 acres of rough heather and bracken land, which forms the ranch, and a croft of 36 acres for growing cereals and keeping goats and old horses.

The original stock of several pairs of silver black foxes were imported from Prince Edward Island, Canada, and the present stock has thriven and improved in size in the more favourable climate of Ross-shire.

Housing and Treatment.—Each pair of foxes is housed in a separate, roomy pen, measuring about 30 feet by 50 and containing two kennels, insulated to ensure a constant temperature inside. Running water is laid on to each pen so that a constant and fresh supply is always available. An unscaleable fence, eight feet high, with an inturned top and bottom, surrounds the ranch to keep out intruders and to prevent the exit by burrowing or climbing of any fox which may have escaped from the pen.

Although the animals have been bred in captivity for years, they retain the instinct of the wild and are hypersensitive, especially during the breeding season. Quiet, peaceful surroundings and the minimum of interference by man are essential at all times and in the breeding season it is advisable for the attendant to wear the same clothes on all his visits to the pen, so that the vixen's suspicions are not roused. The nests are not disturbed until the cubs are three weeks old, when they are taken out, treated for worms and examined for sex; they are examined and weighed again a week later and are not thereafter disturbed until weaning time. In the case of pugnacious families, the cubs are placed in individual pens and reared by hand; these cubs become quite domesticated, can be handled with impunity and are consequently easily dealt with during their breeding season.

The fox is peculiarly immune from most canine diseases and, if the general hygienic and dietetic conditions are carefully supervised, little trouble is experienced. Round-worms and hook-worms are the principal trouble, but these can be kept under control by the use of carbon tetrachloride given in capsule form. The vixen seldom causes trouble during parturition and afterbirth troubles are seldom, if ever, experienced.

Diet.—The adults are fed twice daily and the cubs according to their age and condition. A great variety of feeding-stuffs is used

to ensure that none of the necessary elements is lacking; but horse flesh, on account of its high calorific value, is the staple winter diet.

The cost of maintenance is thus very light and in no other branch of the live-stock industry is it possible to rear animals at such a small cost. Other foods used are rice, oatmeal, maize meal, goats' milk, eggs, rabbits, ox-heads, hearts and tripe, the last named being very valuable and given at least twice a week; apples and dried fruits are essential additions to the diet.

Breeding.—Formerly indiscriminate breeding was rife, quality being sacrificed in supplying sufficient numbers to meet the large demand for foxes as breeders. Now, however, methods have changed and the Scientific and Industrial Research Department of Canada have instituted special stations to deal with breeding problems with a view to improving physique and quality of fur. Great care is now exercised in the mating of foxes so as to eliminate all undesirable features.

Commercial Aspect.—The financial outlook of the industry is very promising. Low maintenance costs and a reasonably quick return make fox farming an attractive venture, which might be taken up as a profitable line by many of our estate owners and others, who could utilise tracts of rough, infertile land to form ranches.

It is interesting to note that, while the Stittenham Ranch in Ross-shire is the only one in Scotland meantime, two others are in course of construction and should be completed in time for the coming breeding season.

The Big Bud of the Black Currant.

IN 1922 Sir George Watt took up the study of the Big Bud of the Black Currant, and carried out experiments at the Crichton Institution, Dumfries, and at the Castlemilk gardens. The following description of the course and results of his experiments is taken from a Note on the subject, published by him in September 1923.

Description of Treatment.—In March 1922 it was found that a plot of black currants (427 Boskoop Giant) at the Crichton Institution was badly infested with the Big Bud Mite. Every known insecticide and method of pruning had failed in previous years to control the pest, and it was accordingly decided to burn the entire plot to the ground. On the 28th March this was done by setting fire to a supply of straw, dry twigs, wastepaper, &c., which had been packed between and among the bushes. To ensure that every square foot of soil had been at least scorched the same firing process was repeated the following day. On the 30th June the plants had commenced to sprout freely; on the 18th July 91·1 per cent. of them had completely recovered, and the mite, up to that date, had nowhere reappeared.

On the 25th March, however, one bush in the plot was discovered to have a few round, purplish-coloured, swollen buds, within which a few live mites were feeding. This bush and those adjacent to it were immediately refired, and by June all of them

had sprouted and were once more a foot high. Firing is thus proved to be a practical measure, so far as the recovery of the plants is concerned; but it may be found necessary to correct imperfect firing by refiring until the mite is entirely eradicated.

Unfortunately the crop failed entirely the first season after burning. This was probably due to the abnormally high temperature during the first four months of the year, followed by frost in May and early June, which naturally resulted in the inflorescences, which were forced on early, failing to set fruit and falling from the bushes. The failure may, on the other hand, be attributed to the fact that the young, sappy shoots may have been more susceptible to frost than old mature wood; but, even if this were the case, it was anticipated that a good crop would be secured the second season after firing.

The latest reports regarding the plot in August and September stated that the plants, which had been very badly infested before firing, had yielded 21 lb. of fruit, and were then healthy, vigorous and mite free.

At Castlemilk, on 24th March 1923, a compact plot of mixed black and red currant bushes was fired and refired. The second firing was rather too intense at some spots, and the consequent death-rate was a little higher than at Crichton; but it is interesting to note that the red currants recovered, which leads the author to suggest that firing might be tried as a cure for the American mildew on the gooseberry.

Season and Method of Firing.—Firing is best done in March, or just before the sap begins to ascend and before migration commences. It is necessary to ensure, as far as possible, complete and uniform firing, not only of the plants themselves but also of the soil, to a depth of two or three inches. It is, therefore, suggested that, a few days before firing, the plants might be cut down and laid on the soil to dry, and would then supplement the straw, &c., necessary for firing. It is also recommended that, in view of a possible hibernation in the soil, the whole surface to be fired should be broken up by a light hoeing just before firing. The combustible material should then be spread uniformly over the soil and within and upon the bushes.

Reversion.—It has been suggested that firing may tend to increase reversion, *i.e.*, to destroy the immunity of certain stocks to Big Bud. The author is at present studying reversion, and considers it an open question whether it should be regarded as a predisposing condition or a consequence of Big Bud; but, if the mite itself is destroyed, the loss of immunity is of little consequence.

"The Aberdeenshire Shorthorn."

MISS ISABELLA M. BRUCE'S *History of the Aberdeenshire Shorthorn* is a book which should appeal not only to those who are engaged in the breeding of this particular type of cattle, but to the much larger circle who appreciate the extraordinary zeal and unremitting effort of men who, though faced with great difficulties, succeeded in converting a cold and unproductive-looking soil into

a fertile and highly productive one. For the development of the Aberdeenshire Shorthorn is concurrent with the reclamation of large tracts ot land which in the early part of last century was more or less a wilderness.

Miss Bruce begins her interesting story with a brief reference to the early pioneers of stock improvement, viz. :—Bakewell of Dishley, the brothers Colling of Ketton and Darnington, the Booths of Warlaby and Bates of Kirklevington. She points out how different was the task of these early improvers from that of the later breeders. Bakewell set the example, which was adopted by his immediate followers, of pursuing systematic in-breeding with the object of fixing a type and establishing a distinctive character. But the men who produced the Aberdeenshire type of Shorthorn had to work on stock that was already related, and their problem was thus much more difficult. That they succeeded in solving the problem merely adds greater lustre to their name and fame.

The migration of the Shorthorn from its home in North-East England through the hands of Robertson of Ladykirk and Rennie of Phantassie, is briefly traced until we come to the year 1827, when the foundation of the first Shorthorn herd in the North-East of Scotland was laid by the versatile and far-seeing Captain Barclay of Ury, Kincardineshire. Their distribution through Aberdeenshire was thereafter only a matter of a few years, and this was accelerated by the fact that inside of twenty years there were two dispersion sales at Ury, which provided the opportunity of securing specimens of the breed to many who might otherwise have been deterred by the necessarily long journey to the North of England.

After this brief account of the introduction of the Shorthorn into Aberdeenshire, Miss Bruce enters on the main part of her story, a description of the foundation and development of every herd in the north-east corner of Scotland. It is a most fascinating story that is told, Men and animals are treated with equal facility; stories of triumphs and of failures, of ideals accomplished and shattered are told in a style that makes their reading a real pleasure.

Naturally, Sittyton and the master mind that directed operations there come in for full consideration, for to Amos Cruickshank belongs the credit of evolving and developing the Scottish type of Shorthorn, whose fame has spread over the whole world. Miss Bruce's history should find a place in the book-shelf of every breeder. As a book of reference it is invaluable, whether to the older breeder or to the beginner, for both of whom the excellent account of all the foundation families of Scottish Shorthorns contains a great wealth of information. The authoress deserves great credit for this book. The importance of the subject was worthy of all the care and trouble she has evidently bestowed on it.

Annual Estimates of the Produce of Crops. THE following statement regarding the produce of crops for 1923 was issued on 14th December:—

Preliminary Statement showing the ESTIMATED TOTAL PRODUCE and YIELD PER ACRE of Wheat, Barley, Oats, Beans, Hay, Potatoes and Roots in SCOTLAND in the Year 1923, with COMPARISONS for 1922, and the AVERAGE YIELD PER ACRE of the Ten Years 1913-1922.

Crops.	Estimated Total Produce.		Acreage.		Average Estimated Yield per Acre.		Average of the Ten Years 1913-1922.
	1923.	1922.	1923.	1922.	1923.	1922.	
Wheat	*Tons.* 63,000	*Tons.* 68,000	*Acres.* 58,789	*Acres.* 65,251	*Cwt.* 21·6	*Cwt.* 20·9	*Cwt.* 21·6
	Quarters. 290,000	*Quarters.* 315,000			*Bushels.* 39·5	*Bushels.* 38·6	*Bushels,* 39·3
Barley (including Bere)	*Tons.* 133,000	*Tons.* 140,000	158,657	157,020	*Cwt.* 16·8	*Cwt.* 17·8	*Cwt.* 17·2
	Quarters. 696,000	*Quarters.* 736,000			*Bushels.* 35·1	*Bushels.* 37·5	*Bushels.* 35·6
Oats	*Tons.* 672,000	*Tons.* 681,000	968,211	988,392	*Cwt.* 13·9	*Cwt.* 13·8	*Cwt.* 14·4
	Quarters. 4,613,000	*Quarters.* 4,812,000			*Bushels.* 38·1	*Bushels.* 38·9	*Bushels.* 39·3
Beans	*Quarters.* 14,400	*Quarters.* 16,000	3,803	3,692	*Bushels.* 30·3	*Bushels.* 34·6	*Bushels.* 36·7
Hay from Rotation Grass	*Tons.* 657,000	*Tons.* 679,000	414,527	431,601	*Cwt.* 31·7	*Cwt.* 31·5	*Cwt.* 30·8
Hay from Permanent Grass	139,000	132,800	108,526	101,778	25·6	26·0	26·0
Hay from Timothy Meadows	94,000	91,000	44,331	43,026	42·5	42·5	41·5
Potatoes	820,000	1,191,000	136,976	157,404	*Tons.* 6·0	*Tons.* 7·6	*Tons.* 6·6
Turnips and Swedes	6,561,000	6,880,000	409,642	404,112	16·0	17·0	16·6
Mangolds	25,200	34,600	1,631	2,008	15·4	17·2	19·4

NOTE.—The abnormal mildness that prevailed during the latter months of 1922 continued throughout the first three months of 1923. The sowing of wheat was carried out under favourable conditions and the crop brairded well. Growth was slow during the summer months, owing to the wet season and the unusual lack of sunshine, but the crop matured well, and on the whole has yielded satisfactorily. In many districts wheat was the best cereal crop of the year, and nowhere was it affected by disease. In the case of barley the soil was not in good condition at seeding time and germination was slow, while during May and June growth was checked to some extent by frost. Ripening was slow as a result of the wet and sunless season, and the ears did not fill out so well as usual. Oats were a satisfactory crop in the north-eastern and eastern counties generally and were harvested in good order. Elsewhere, however, the wet conditions and lack of heat during the growing season checked development and materially reduced the yield. Grub and wireworm were prevalent in many districts and caused considerable damage, especially amongst lea oats.

In most districts the planting of potatoes was accomplished in March and April under fairly satisfactory conditions, but the sowing of turnips was delayed owing to the difficulty in securing a good seed-bed. The growth of both crops was considerably affected by the prolonged spell of cold and wet weather during the summer months. In the northern, western and south-western districts generally potatoes and turnips were light crops, and, taking the country as a whole, the yields were below those of 1922. Some damage was caused to the potato crop by disease and blight, while finger-and-toe was more prevalent than usual amongst turnips. The growth of mangolds was also checked during the season, and it will be seen that the yield is considerably below the normal.

The total produce of wheat, amounting to 63,000 tons, is less than that of last year by 5000 tons, or 7·4 per cent.; the area under the crop is less by 6462 acres, but the average yield per acre, estimated at 21·6 cwt., is nearly three-fourths of a cwt. more than last year, and equals the average of the previous ten years. Barley, with a total produce of 133,000 tons, shows a decrease of 7000 tons, or 5·0 per cent.; the area under the crop is greater by 1637 acres, but the yield per acre, 16·8 cwt., is 1·0 cwt. less than last year, and falls short of the decennial average by 0·4 cwt. The total produce of oats, 672,000 tons, is less than last year's total by 9000 tons, or 1·3 per cent.; the area sown, 968,211 acres, shows a diminution of 20,181 acres from last year, while the yield per acre, 13·9 cwt., is greater than last year by 0·1 cwt., but is 0·5 cwt. less than the ten years' average. The produce of beans is recorded by measure and not by weight. The total produce, 14,400 quarters, is less than that of last year by 1600 quarters, or 10 per cent. The area under the crop, 3803 acres, exceeds last year's area by 111 acres, but the yield per acre, 30·3 bushels, is

below last year's by 4·3 bushels, and below the ten years' average by 6·4 bushels. The yield per acre is the lowest recorded since the year 1895.

The total produce of hay, taking all kinds together, is 890,000 tons, which is 12,000 tons, or 1·3 per cent., less than last year. Hay from rotation grass shows a total produce of 657,000 tons, a decrease of 22,000 tons, or 3·2 per cent. The area is less by 17,074 acres, but the yield per acre, 31·7 cwt., is greater by 0·2 cwt. Of other hay, the total production of which is 233,000 tons, or 10,000 tons in excess of last year, ordinary Meadows yielded 139,000 tons, and Timothy Meadows 94,000 tons; the former with an increase in area of 6748 acres has a yield of 25·6 cwt. per acre or 0·4 cwt. less than last year, while the latter with an unchanged yield per acre has an acreage of 44,331, or 1305 acres more than in 1922. The average yield of the two together, which is not shown in the table, is 30·5 cwt., or 0·1 cwt. below the decennial average.

The total produce of potatoes is estimated at 820,000 tons, which is 371,000 tons less than last year's crop, and is the smallest recorded since the abnormally low return of 1916. The area under the crop, 136,976 acres, shows a decrease of 20,428 acres, while the yield, 6·0 tons per acre, is 1·6 tons less than the record yield of 1922, and 0·6 ton below the decennial average. Turnips and Swedes show a decrease of 319,000 tons, the total produce being 6,561,000 tons; the area under the crop, 409,642 acres, is greater than last year by 5530 acres, but the yield per acre, 16·0 tons, is exactly 1·0 ton per acre lower than in 1922 and 0·6 ton less than the decennial average, the diminution in total produce being thus due to the decline in yield. The total produce of Mangolds, 25,200 tons, is 9400 tons less than in 1922, and is the smallest recorded since 1897; the area returned, 1631 acres as against 2008 acres in the previous year, is the smallest recorded since 1898; the yield per acre, 15·4 tons, is lower than last year by 1·8 tons, and is below the decennial average by 4·0 tons.

Guide to Current Official Statistics.

ABOUT four years ago a Committee of the Royal Statistical Society presented a petition to the Government, urging that an inquiry should be made into existing official statistics with a view to remedying certain defects that were alleged to exist. Shortly afterwards the British Empire Statistical Conference met in London, and recommended, *inter alia*, that an Imperial Statistical Bureau should be established for the purpose of collecting and issuing statistics relating to the whole Empire. This recommendation has not been carried into effect, but as a result of the two movements mentioned above there was set up in 1921 a Permanent Consultative Committee on Official Statistics, consisting originally of 24 members, 18 representing the principal United Kingdom or English departments that issue statistics,

while Scotland and Ireland had each 3 representatives; this arrangement has now been altered as regards Ireland. The Committee has no executive power, but, acting in a purely advisory manner, it endeavours to secure greater uniformity in the presentation of official statistics than was formerly observed, and to effect such improvements as may be expedient.

One of the duties laid upon the Committee was the preparation of a *Guide to Current Official Statistics*. and the first issue of this *Guide*, dealing with the year 1922, was recently published by H.M. Stationery Office. The *Guide* is divided into two parts, in the first of which the Departments, numbering no fewer than 76, are arranged in alphabetical order, with particulars of the periodical or special statistical volumes and returns that they issued in 1922, including in some cases issues made early in 1923. Each publication has a serial number. The second part is a subject index, arranged on a scheme carefully drawn up, with numerous cross-references. The publications dealing with each subject are indicated by their serial numbers.

A study of the *Guide* will show how fully the facts of social and industrial life, in their numerical aspect, have been ascertained and made available. Interest in statistics has increased in recent years, and the *Guide* should be useful to all who take an intelligent interest in national affairs.

Copies may be obtained either through any bookseller or directly from H.M. Stationery Office, 120 George Street, Edinburgh, price 1s. net, or by post 1s. 2½d.

Acreage under each Variety of Potatoes in 1923.

A STATEMENT is printed at page 120 showing the acreages under certain varieties of potatoes in Scotland in 1923, as returned by growers of 1 acre and over.

The area under First Earlies, 17,300 acres, shows an increase over the previous year of 800 acres, or 5 per cent. Epicure, with 9,410 acres, is still the outstanding variety under this head—the area grown, although less than last year, comprising more than half of the total area under First Earlies. The area under Sharpe's Express, 2,047 acres, has practically doubled, while Duke of York shows an increase of 627 acres, or 36 per cent.

Second Earlies were grown to a less extent than in 1922, the diminution in area being 5,864 acres, or 24 per cent. Great Scot and Arran Comrade again show considerable decreases in area, while British Queen remains unchanged. The premier position is, however, still held by Great Scot, the area under this variety, 9,681 acres, being 51 per cent. of the total area returned under Second Earlies.

The area under Maincrops totalled 82,725 acres as compared with 98,089 acres in 1922, a decrease of 16 per cent. Of the varieties occupying 10,000 acres or over, Arran Chief, with 21,021 acres, has diminished in area by 8,452 acres, but still maintains its position as the most popular maincrop. King Edward VII., with 16,899 acres, again holds second place, but Golden Wonder, with

12,403 acres, an increase of 58 per cent., now occupies third place instead of Kerr's Pink, the acreage under the latter being somewhat less than last year.

THE following notes, which refer to experiments conducted at Craibstone, were compiled by Mr Wm. Findlay of the North of Scotland College of Agriculture.

Effect of Grazing New Grasses during Winter on Weight of Hay.

There are great differences of opinion amongst farmers as to the advisability of grazing new grass during winter. On the heavier classes of soil, and especially in wet weather, it is generally held that great damage is done by grazing, but, on the other hand, where the soil is of a lighter character, and especially if the grazing is done during dry weather, it is held by many that the grazing has little or no effect upon the hay crop. To get information upon this point two parts of a field were fenced off and left ungrazed, while the rest of the field was fairly closely grazed down during the month of February. The whole area was dressed during the month of April with $\frac{3}{4}$ cwt. sulphate ammonia per acre. It was quite apparent early in the season that the ungrazed parts were very much richer in Red Clover. The weights of the hay from the two areas were—

Ungrazed (average of two plots) . .	70·8 cwts.
Grazed	60·5 ,,

Here then there was a balance of 50 stones of hay per acre in favour of the ungrazed part. Valuing this at the comparatively low figure of 6d. per stone there was a loss of 25s. per acre through grazing the new grasses—a figure which would certainly be more than the value of the grazing under average conditions.

It may be pointed out that no Italian Ryegrass was used in the grass seed mixtures. Where Italian Ryegrass is used it would very probably be an advantage to graze down the new grasses rather later in spring, as this would prevent, to a certain extent, the Italian Ryegrass from checking, as it usually does, the growth of the Red Clover.

Effect of Phosphatic Manures on Hay and Pasture.

IN many districts it is still the custom to dress new grasses in the autumn or early winter with basic slag and other phosphatic manures. While it may be the case that such dressings are an advantage on land in poor heart, or where the minimum amount of phosphates has been applied to the previous turnip and grain crops, it would seem that they are unnecessary where the land is in comparatively good heart, or where the two previous crops have been well manured.

Basic slag or ground mineral phosphates have now been applied to every field on the farm of Craibstone, and the results over a period of seven or eight years have been consistently unfavourable to the application of phosphatic manures at this time. The results of one set of trials only need be given here. In the autumn of 1922 $\frac{1}{2}$ ton of basic slag was applied to one part of a field and $\frac{1}{2}$ ton of ground mineral phosphates to another, the rest of the field being left untreated. The weights of the hay in 1923 were practically the same on all plots, and merely confirm those of former years. In former years, too, it has been noticed that not only had the phosphatic dressing no effect upon the hay, but there was no marked improvement in either the quantity or quality of the pasture in subsequent years. This is undoubtedly due to the fact that such surface dressings can help the growth of only surface-growing plants, particularly White Clover. Generally, however, on soils that are in good condition no great difficulty is experinced in getting quite a good stand of White Clover without any such dressing, and, therefore, such dressings are often unnecessary. The results, of course, may be entirely different where phosphates are applied to the surface of old pasture land. In the great majority

of soils, but particularly the poorer classes, the surface sooner or later gets over-run with fog, which tends more and more to press out the White Clover, and in order that the latter may again get a roothold a phosphatic dressing is certainly required. In temporary pastures, however, of three or four years' duration, White Clover suffers little, if any, from competition by fog.

Trial of Canadian Cattle.

IN an experiment, which was carried out primarily for the purpose of determining the relative values of different systems of seeding pasture, eight Canadian and ten home-bred bullocks were made use of. The home-bred cattle had been on turnips and straw for eight weeks, and were then, along with the Canadians, for a week on pasture before the commencement of the experiment. At this time both lots were, as far as could be seen, in the same condition. The Canadian cattle were all over three years old, and weighed on the average 10 cwts. 3 qrs. 1 lb. The home-bred cattle were all under two years old, and weighed on the average 7 cwts. 3 qrs. 9 lbs. No food other than the grass was fed during the course of the experiment, which extended over eleven weeks, from the 10th May to the 25th July. During the first month both classes made practically the same live-weight increase—approximately 100 lbs. This works out at the very satisfactory increase of 3¾ lbs. per day. For the remainder of the period, however, the Canadian cattle did rather better than the home-bred—the live-weight increase in their case being 140 lbs. as against the 122 lbs. for the home-bred cattle. This works out at about 3 lbs. per day for the Canadians and 2½ lbs. for the home-bred. The average live-weight increase over the whole period was 2·9 lbs. per day for the home-bred and 3¼ lbs. for the Canadians.

In estimating the returns from the different classes, however, we must remember that the larger cattle would require at least 25 per cent. more food than the smaller, and that, therefore, if we calculate the results on the basis of the return in live-weight for food consumed, it will be seen that the home-bred cattle did slightly better than the Canadians.

All the cattle were marketed on the same days and in the same market, and as indicating the difference in value between the two, the Canadian cattle brought on the average from 55s. to 60s. per live-weight cwt., whereas the home-bred cattle brought from 65s. to 70s.

Agricultural Returns for Scotland, 1923.

THE Abstract of the Agricultural Returns, printed on pp. 121-128, shows that the total area under crops and grass amounts to 4,724,438 acres, a decrease of 1061 acres as compared with 1922, the arable land having decreased by 39,926 acres, while the area under permanent grass is greater by 38,865 acres. The land under rye-grass and other rotation grasses and clover has decreased by 5429 acres, the decrease in the area under other crops being thus 34,497 acres. This decrease is more than accounted for by wheat, oats and potatoes, which show a combined loss of 47,000 acres. The area under wheat shows a decrease of 6462 acres or 9·9 per cent., that under barley has increased by 1637 acres or 1·0 per cent., while that under oats has decreased by 20,181 acres or 2·0 per cent. The total area under the cereal crops is 1,193,300 acres or 25,093 acres less than last year. Beans show an increase of 111 acres or 3·0 per cent. Potatoes have decreased by 20,428 acres or 13·0 per cent., while the area under turnips and swedes is greater by 5530 acres or 1·4 per cent. The area under mangolds, 1631 acres, is 373 acres less than last year, and is the lowest recorded since 1898. Rape shows an increase of 3210 acres or 28·8 per cent.: the area under vetches, tares, etc., for fodder is also greater, the increase being 666 acres or nearly 7 per cent. Carrots have decreased by 122 acres or 23·9 per cent., but cabbage, with an area of 4278 acres, is greater by 490 acres or 12·9 per cent. The other crops show little change. The net decrease in

the area under rotation grasses and clover, 5429 acres, is only 0·4 per cent.; the area for hay, however, has decreased by 17,074 acres or nearly 4 per cent., while that for pasture shows an increase of 11,645 acres or 1·1 per cent. The area under permanent grass is greater by 38,865 acres or 2·8 per cent., the area for hay being greater by 8053 acres and that for pasture by 30,812 acres. The total area cut for hay was 567,384 acres, or 9021 acres less than last year.

The area under wheat, barley, oats and potatoes this year is, in round figures, 1,323,000 acres; this is 45,000 acres less than last year, and 31,000 acres less than in 1916, which was the basal year for the food production campaign.

The live stock returns show that the numbers of cattle, sheep and pigs have increased, while horses are less numerous. The decrease in horses is most noticeable in the "unbroken" classes, which show a total diminution of 6823, of which 5290 are "one year and above" and 1533 are "under one year." Horses used for agricultural purposes have decreased by 608, while "other horses" are fewer by 505, the total decrease thus being 7936 or 3·8 per cent. Cows in milk have increased by 2799 or 0·8 per cent., while cows in calf have decreased by 2563 or 5·7 per cent.; heifers in calf, however, show an increase of 2896 or nearly 6 per cent. Bulls used for service have decreased by 856 or 4·7 per cent. Other cattle of all classes show considerable increases, the numbers of those of two years and above being greater by 26,199 or 13·2 per cent., those of one year and under two by 15,230 or 6·1 per cent., and those under one year by 3078 or 1·4 per cent. The total number of cattle has thus increased by 46,783 or 4·1 per cent. Sheep are also more numerous than in 1922, the total number showing an increase of 101,626 or 1·5 per cent. Breeding ewes have increased by 30,778 or 1·1 per cent., and lambs by 40,023 or 1·5 per cent., while other sheep of one year and above are numerically greater by 30,818 or 3·2 per cent.; the number of rams is practically unchanged. All classes of pigs have increased in number, sows kept for breeding by 6078 or 33·0 per cent., boars used for service by 474 or 22·0 per cent., and other pigs by 28,591 or 21·9 per cent. The total increase in the number of pigs amounts to 35,143 or 23·3 per cent.

The returns collected this year include statistics of the acreage owned by the occupiers of the holdings and particulars relating to labour. These figures are not included in the printed abstract.

The total area of land under crops and grass owned by occupiers of holdings this year amounts to 883,558 acres as compared with 820,749 acres in 1922, showing an increase of 62,809 acres.

Labour employed on holdings (exclusive of the occupiers, their wives and domestic servants) totalled 120,024 as compared with 124,616 last year, a decrease of 4592 or 3·7 per cent. Of these, 100,733 were returned as regular workers, and 19,291 as causal workers. Regular workers comprised 80,440 males and 20,293 women and girls, while casual workers were made up of 9525 males and 9766 women and girls.

Agricultural Conditions.

THE weather during September was very unsettled, rain was frequent, and in some cases heavy, and as a result the cutting and ingathering of the cereal harvest was retarded to a greater or less extent. In the western, south-western and northern counties, and especially in the western islands, harvest progressed very slowly, while uncut fields were badly laid by rain and wind. During October the weather was fairly favourable in Kincardine, Forfar, Fife, the Lothians, Peebles and Berwick for the completion of the cereal harvest and for potato lifting; in the north-eastern counties the conditions were more changeable, but the seasonal work was not interrupted to any serious extent. Elsewhere, however, the weather was cold and wet during the greater part of the month; harvesting operations were rendered very difficult, and at times work was practically impossible. In Caithness, Sutherland and Inverness a

considerable portion of the grain crop was in stook at the end of October, while in late districts there were still many fields to be cut. During November the weather was wet, cold and boisterous in the western, south-western and northern districts, and in Orkney and Shetland, and at intervals there were spells of frost and some falls of snow. As a result the soil became very sodden, and little or no progress could be made with autumn cultivation in these parts. In Caithness about half of the corn crop was still lying out in the fields at the end of the month, while in Shetland and in the late districts of South Ayr and Inverness a proportion of the grain crop had not been secured. Satisfactory progress was made with outdoor work in Kincardine, Forfar and most districts of Perth and Aberdeen until the last week of November, when heavy falls of snow interrupted operations to a great extent. Ploughing is well forward in the south-eastern counties and Fife, but the sowing of wheat, the lifting of turnips and the pitting of potatoes have been retarded owing to the wet state of the land.

The cutting of wheat began in a few districts in August, but only a small proportion of the crop was secured by the end of September; in the majority of cases harvest was not completed until the second or third week of October. Taking the country as a whole the wheat crop had been a good one, and the yield of grain is a full average. The harvesting of barley was completed practically everywhere by the end of the third week of October, although at the close of the month there were still a few fields to cut in North and East Perth, Roxburgh, Orkney, Lewis and Uist, and on upland farms in Ross. In the northern counties the crop was damaged to some extent by rain and high winds, while from South-West Forfar, North-East Fife, Wigtown, Orkney and the Western Islands the grain is reported to be of inferior quality. Elsewhere, however, the crop was generally secured in good order, and the grain is of average or good quality. The oats harvest was unusually protracted owing to unfavourable weather, and considerable difficulty was experienced in securing the crop, especially in the late districts of the northern counties. The reports on the condition of the crop are more varied than those regarding other cereals. Where the crop was harvested in good order the quality of the grain is fairly satisfactory. In districts, however, where the harvest was prolonged, the crop was considerably damaged by wind and rain, and the yield and condition are correspondingly below the normal.

The lifting of potatoes was retarded in several districts owing to the broken weather and the wetness of the soil, while in others the lateness of the tubers in ripening delayed operations to some extent. In North-East Aberdeen, South-West Perth, Shetland, Harris, Lewis, Central Argyll, Ayr and Wigtown lifting only commenced at the end of October, while in Orkney, Caithness, Sutherland, Uist and Skye the work was in progress during November. In the western and south-western districts the tubers are smaller than usual, while the quality of the crop varies from fair to indifferent. In Caithness growth was slow owing to the excessive wet, and the yield is light, while in the Western Islands the quality of the potatoes and the yield are both much below the normal; elsewhere the crop has yielded satisfactorily. Reports of disease to a greater or less extent have been received from Banff, Central Aberdeen, Kincardine, North-East Forfar, South-West Fife, Dumfries, Kirkcudbright and the Western Islands.

The lifting of turnips and swedes was completed or well advanced in several districts at the end of November. In many cases, however, lifting is in arrear owing to the unfavourable weather conditions, while in some parts the turnips are being lifted as required. Generally speaking, turnips are smaller than usual, owing to the wet weather and the absence of sunshine during the growing season; on wet and stiff soils the yield is considerably below the average and the roots are of inferior quality. Swedes, however, are a fair crop in most districts. Finger-and-toe is present in Caithness, Ross, Sutherland, Kincardine and some parts of Aberdeen, while in several of the south-western districts many fields have gone to seed. Mangolds are generally free from disease and of good quality, but in most districts the bulbs are rather undersized.

"Seeds" grass is almost everywhere reported to be vigorous and healthy. In Caithness, Inverness, Lewis and Dumbarton, however, growth has been slow, owing to the cold and wet season.

The weather during November was to a great extent unfavourable for cultivation, and arrears are reported from many districts, especially in the northern, western, and south-western counties. In many parts satisfactory progress has been made with stubble ploughing, notwithstanding the late and protracted cereal harvest. Wheat sowing was completed or well advanced in several districts at the end of November, but in North-East Fife, the Lothians, Berwick and North-West Lanark sowing is not so far forward as is usual at this period.

Feeding cattle are in good or in fair condition. Winter keep is not over plentiful in several districts, and it is questionable whether the supply will be sufficient for the needs of a normal winter. Dairy cows are in average condition, and, generally speaking, the milk yield has been satisfactory. Sheep on lowland farms have done well in most cases, but the condition of hill flocks was more or less affected by the trying weather during November.

Regular labour is plentiful everywhere, and in several districts the supply is stated to be in excess of present requirements. Experienced dairymaids and byremaids are somewhat scarce in Stirling, Renfrew and Ayr.

RECENT PERIODICAL LITERATURE.

A number of the following extracts and summaries are taken from recent bulletins of the International Institute of Agriculture. Full references to the bulletins, and to the original publications quoted therein, may be obtained on application to the Secretary, Board of Agriculture for Scotland, York Buildings, Edinburgh.

Sunflower Silage. *A. Amos and H. E. Woodman (School of Agriculture, Cambridge University), The Journal of Agricultural Research, Vol. XIII., Part 2. London, April 1923.*—An account of trials with the "Giant Ensilage," sunflower variety, grown for storage in the silo. This crop, planted on light gravel soil, gave a yield of 20 tons of green matter per acre, containing 18·5 per cent. dry matter, which compared favourably with the maize crop grown simultaneously (14 tons per acre).

After storage in the silo for three months the silage was examined and appeared to be of good quality, after removal of the top layer of waste material. An outstanding feature of the results was the extremely low percentage loss of dry matter which occurred, namely 4·8 per cent., appreciably lower than any of the corresponding figures obtained in the ensilage trials with oats and tares. The crude protein underwent very little change, but the digestibility value was somewhat lowered. Full data are given with reference to the composition and changes in content of dry matter of green sunflower and sunflower silage.

Trials made in the United States have already demonstrated the value as a stock feed and as a substitute for maize silage. An experiment to test the palatability of this fodder was made at Cambridge. The authors consider, however, that further investigations as to digestibility and value as a cattle feed, and improved methods of cultivation in order to reduce the fibrous nature of the stems, are necessary before sunflower silage can be recommended on a large scale for feeding stock.

The Sugars and Albuminoids of Oat Straw. *S. H. Collins and B. Thomas (Agricultural Department, Armstrong College, Newcastle-on-Tyne), The Journal of Agricultural Science, Vol. XII., Part 5, Cambridge, 1923.*—M'Callum has proved that although maize grain is a very incomplete stock-feed, adult cattle thrive if fed the whole maize plant, which also promotes the development of suckling calves when it is given to their dams.

This agrees with the opinion held that the whole plant of grain cereals has about the same composition as meadow hay. Many agriculturists even maintain that straw makes an excellent stock-feed. The difficulty, however, consists in obtaining straw that animals will eat readily.

The authors studied the chemical composition of straw and the factors influencing its quality. Oat straw was chosen for the experiments, as this cereal is much cultivated in Great Britain, and they studied the effect exercised by climatic and meteorological factors and by the application of fertilisers.

Collins had already previously worked on these subjects, and was enabled to resume his investigations owing to a grant made by the Ministry of Agriculture.

The sugar content of oat straw varies within very wide limits, ranging from 6·33 to 9·47 per cent. The percentage present is much affected by the meteorological conditions during ripening. This sugar disappears by degrees; if the straw is kept dry its sugar content decreases slowly, otherwise the percentage falls rapidly. The sugar in oat straw is chiefly levulose, while that of wheat is principally dextrose. In oat straw levulose never forms less than 50 per cent. of the whole; the rest of the sugars are derived to a great extent from saccharose, one molecule of which consists of levulose.

The protein of straw calculated according to the usual formula, N × 6·25, also has a wide range of variation, extending from 1·12 to 8·05 per cent. This variation depends to a considerable extent upon the nitrogen content of the soil, the organic nitrogen present being the most important factor.

A useful circle is therefore established, for the nutritious straw supports a large number of stock which, in their turn, liberally manure the soil, thus producing a straw rich in protein. The climate also has a great effect; for this reason in the northern districts, where the season is short, the crop is often harvested early, in order that the grain may not have time to abstract the protein from the culms, which therefore remain more nutritious. This explains why Scottish oat-straw is more suited for a cattle-feed than the straw of oats grown in England. Moisture is also an important factor. In dry seasons the oats are cut early, before the seeds have had time to draw upon the nitrogenous reserves in the culms.

So-called sweet straw is in reality rich in protein, not in sugars. The food value of straw seems to depend chiefly upon its protein content.

Cod-Liver Oil in the Feeding of Cattle and Swine. *J. C. Drummond, K. H. Coward, J. Golding, J. Mackintosh and S. S. Zilva, The Journal of Agricultural Science, Vol. VIII., Part 2, Cambridge, 1923.*—The object of the experiment was to determine whether it is possible to maintain the vitamine content of cow's milk by adding to the ration of the cow small quantities of some substance that is very rich in vitamine A, such as cod-liver oil.

Three lots of grazing cows were put into the cow-shed at the beginning of December, after the vitamine content of their milk fat had been analysed. From the time they were removed from the field, the animals were given a ration containing no vitamine A, and as soon as the fat had decreased they were divided into two lots, one of which (lot *a*) was fed pure cod-liver oil, in quantities increasing progressively from 75 gm. to 100 gm. per day, while the other (lot *b*) received the same amounts of neutralised olive oil. There was a constant and very remarkable increase in the amount of the vitamine A present in the fat of lot *a*. The vitamine content of the fat of lot *b* also increased, but always remained lower than that of lot *a*. During the whole time the cows were kept in the shed, groups II. and III. received the same rations as group I., except that from February the cows of group II. were allowed to graze for a short time each day, while those of group III. could graze *ad lib.* throughout the whole winter. The analysis of the fat content of the milk of these animals showed that the vitamine concentration increased together with the amount of lipochromes in proportion as the grass became richer, but it was always lower than the vitamine concentration in the milk-fat of the animals belonging to the first group.

The cod-liver oil used for feeding farm animals should be clear and bright: it is best when the colour is not deeper than a golden-yellow.

In the case of pigs, from 7 to 18 gm. per day are enough to stimulate the growth and improve the general condition of the animals. In the opinion of the authors, a stronger dose (42 to 56 gm. per day) of first quality oil is very good for sows in farrow, aud increases both the milk secretion and the vitamine A. It was found by experiment that this oil is readily taken by pigs, especially when they have no access to a pasture and are fed a ration with low vitamine content. Although the meat and fat never acquired any taste or smell of cod-liver oil, the authors advise that its use should be discontinued for some little time before the pigs are slaughtered.

The authors also found that cows readily take 14 to 56 gm. of cod liver oil daily, and that even if the dose were increased to 112 gm. per day, there was no smell or change of colour in the milk.

The Necessity for Calcium and Phosphorus in the Diet of Dairy Cows. *E. B. Meigs (Dairy Division, United States Department of Agriculture), Journal of Dairy Science, Vol. VI., No. 1, Baltimore, 1923.*—The author, after reference to the work of Forbes and Hart, sums up the evidence so far presented by stating that it appears that liberally milking cows are usually able to maintain themselves in calcium and phosphorus equilibrium (1), when they receive an abundance of good lucerne hay, combined with concentrated foods, rich in phosphorus.

The Ministry of Agriculture of the U.S.A. is at present making an experimental test to establish the value of coarse foods with a low calcium content which are fed instead of lucerne. To one group of cows is given a mixture of grains high in protein and timothy hay only, or timothy hay and silaged maize; another group received the same rations with calcium carbonate added, or a ration containing the same or approximately the same protein content, but with lucerne hay instead of timothy. These experiments have not yet been completed, but the results obtained show that sooner or later the yield of milk from cows who receive forage with a low calcium content is greatly diminished, and that this decrease is mostly due to the calcium deficiency.

On the other hand it appears that the liberally milking stall-fed cows can be kept in calcium equilibrium only if fed on large quantities of forage with a high calcium content, as for example, lucerne hay.

Since the experiments of Fingerling and Hart many others have been made, and seem to indicate that the assimilation of calcium and phosphorus is influenced by vitamines. Dairy cows on pasture can maintain calcium equilibrium on a smaller absolute calcium intake than those on dried materials with or without maize silage.

Forbes reported that in the case of cows that were dry or giving only small amounts of milk, the calcium and phosphorus balances were both usually positive. The cows used in these experiments, however, received lucerne hay.

Some tests were made by the Ministry of Agriculture of the U.S.A. to determine what influence the substitution of timothy hay for lucerne had on cows giving small amounts of milk. Cows on timothy hay have continued to give a small amount of milk for many months consecutively, but these cows were being fed on rations which contained much more protein and nutritive matter than they required according to any of the feeding standards.

It is likely, therefore, that the results indicated only confirm the theory that cows giving small amounts of milk can eat much more food than they require, and compensate in that way for the absence of a particular substance in the rations given to them.

It is, perhaps, not too strong a statement that it is always bad practice not to include liberal quantities of leguminous hay in the rations of dairy cows which are receiving only dry feeds and silage.

The dairy farmer must not expect to obtain a large yield of milk in winter, if he cannot give his cows lucerne or other leguminous hay in large quantities. It will probably pay him, also, to see that each of his cows has a dry period of

two months, and that during this period she receives twice the maintenance ration in protein and total nutrients.

The author also states that, so far, experimental work has not been sufficiently advanced to demonstrate whether lucerne hay can be replaced by other leguminous hays to provide a source of calcium, or how the calcium requirements of cows on different kinds of pastures can be supplied.

The Influence of Feeds and Feeding on the Type of Market Hog. *G. B. Rothwell (Dominion Animal Husbandman), The Agricultural Gazette of Canada, Vol. X., No. 2, Ottawa, 1923.*—The author's experiments carried out on the Central Experimental Farm, Ottawa, with a view to determining the effect of feeds and feeding on the condition of fattening-hogs, yielded the following results. The young pigs, given a ration of skim milk with the minimum of crude fibre, developed well, and their growth was little, if at all, arrested at the time of weaning; whereas another lot fed the same ration, but without the skim milk, fattened more slowly. The animals that received a mixture of meals, meat-meal and milk, required a little more food than those given no meat-meal, but turned out fine, large, fat pigs, superior to those fed on meals alone. The pigs given meals and meat-meal, but no milk, did not develop properly; they were deficient in length and other qualities, and too big.

Two lots of pigs of the same breed and type as those used in the above experiment were fed on maize, oats, sharps and meat-meal, but one lot was given these rations unmixed and distributed by means of an automatic feeder, while the rations of the other lot were mixed and given in limited amounts It was found that the first lot preferred a ration containing about 80 per cent. maize, and fattened quicker than the second lot, which consumed less grain per lb. increase in live-weight and was classed in the select category. The other lot of animals was a little fatter and taller, especially at the shoulder. These experiments all show that any system of feeding that tends to cause too early a formation of fat in hogs fattened for bacon, and hinders maximum bone and muscle development during the first four months, has the effect of producing fat, short-bodied animals, lacking in uniformity.

The observations of many years have also proved that it pays better to fatten hogs in cheaply constructed enclosures rather than in closed piggeries, in which they do not grow such a good shape.

Studies in Swine-Feeding. *A. Poulain, Office régional agricole du Midi, Bulletin trimestriel, No. 4, Marseilles, 1922.*

Experiments with bone-meal: (1) Bone-meal when fed to young, growing pigs reduces the cost of meat production, but the animals develop very slowly. The addition of 90 gm. of bone-meal to the daily ration of pigs weighing 35-50 kg. has the effect of producing a further average live-weight increase of 1·2 kg. per head per week, and of savings 10 per cent. on the food required to give 1 kg. of meat.

(2) *Feeding bone-meal* to sows in farrow caused an increase in the weight of the piglings at birth, their more rapid growth during the suckling period (1 kg. extra weight at weaning), and 16-20 per cent. less decrease in the weight of the nursing sow. These results were obtained by the addition of 100 gm. of bone-meal to a ration of 1 kg. palm-oil cake + 1 kg. bran during the gestation period, and of 1·5 kg. to 1·5 kg. of these feeds per sow of 100 kg. during the suckling period. Other experiments carried out in 1922 included:

Feeding tests with fish-meal: (1) In the case of growing animals, fish-meal fed at the rate of 200 gm. per 1200 gm. of other food (bran, cereal flour, palm-oil cake) increases the digestive return, that is to say, the proportion of meat produced to food consumed, by about 25 per cent.

(2) By adding 200 gm. of fish-meal to the ration of a sow in farrow fed 1·1 kg. palm-oil cake + 1·1 kg. bran, and 300 gm. to the ration of a nursing sow (1 kg. palm-oil cake + 1 kg. bran + 1 kg. maize), the weight of the piglings at birth was increased by 100 gm. or more, and the loss of weight by the sow during the suckling period fell 30-40 per cent., while the health of the piglings was better, and they put on more weight.

The fish-meal used contained 13 per cent. moisture and fat and 3-4 per cent. of salt, and produced no digestive troubles.

First Generation Hybrids for Egg Production. *W. T. S. Ellerman, The National Poultry Journal.*—The author states that all the White Leghorn fowls now reared in England belong to a few families imported from America and Australia, or else have been bred in the country for show purposes.

The breed only became popular about twenty years ago, and the flocks have never been improved by the introduction of fresh blood. Since 1903, the race has been continued by pure-bred birds alone, which has resulted in a great degree of consanguinity. Inbreeding is necessary to fix certain characters, but after a time it produces diminished vitality, to which cause the author attributes the high percentage of mortality found among broods of White Leghorn, White Wyandotte and Rhode Island Red chicks.

Recourse must be had to crossing in order to improve egg-production, therefore every poultry-rearer should keep some birds for experiments and as a means of infusing fresh blood into pure breeds.

It is maintained that a first cross between two pure breeds will lay as many eggs as its mother and female relatives on the paternal side, and be endowed with more vitality than its parents.

The fact that a high egg yield is a genetic factor does not appear to have been sufficiently taken into account. If the parents come from good laying stock then progeny will inherit this character, irrespective of any crossing.

The author is of opinion that, before long, the whole stock of egg farms will consist of the first generation hybrids of breeds celebrated for prolific egg-production.

The Chantecler Breed of Fowls. *L. J. Cole (University of Wisconsin, Madison), The Journal of Heredity, Washington,* 1922.—The name Chantecler has been given to a new race of fowls bred at St. Anne de Bellevue by Brother Wilfred, the Trappist Monk in charge of the poultry breeding section of the Oka Agricultural Institute (Prov. of Quebec). One of the chief merits of the new breed is its power of withstanding the cold winters of a northern country. Characteristics: a dual-purpose bird (good layer and table-fowl), lays eggs even in winter; plumage short, thick and white; comb and wattles reduced, for these appendages soon alter as a result of severe cold. The Cornish fowl was chosen as the point of departure for selection, as this bird possesses in a high degree the desired conformation, vigour and type of comb and wattles. In order to obtain good laying qualities, the Cornish breed was crossed with the White Leghorn, winter egg production being secured by an admixture of Rhode Island Red, Wyandotte and Plymouth Rock blood. The first crosses were made in 1908, with a dark Cornish cock and a White Leghorn hen on the one hand, and a Rhode Island Red cock and a White Wyandotte hen on the other. In 1909, the whitest hens of the first cross were mated with a fine white cock of typical Wyandotte type obtained from the second cross. In 1910, the hens of the preceding generation which were nearest the desired type were mated with a handsome White Plymouth Rock cock weighing 9¾ lbs. The selection was continued for two or three years after the colour had become almost uniform, the egg-production greatly increased and the combs and wattles had begun to shrink. The hybrids were very strong and active.

In 1913, the flock was divided into two branches; in one a limited amount of inbreeding was practised, while in the other the hens were mated with a Wyandotte cock. As was to be expected in such a recently-created and complex breed, a certain degree of variability still exists, but the characters were sufficiently fixed for the breed to be recognised by the American Poultry Association in 1920. The author gives the standard adopted by the Association of Breeders of the Canadian Fowl Chantecler. The typical weights are: 9 lbs. for the cock, 8 lbs. for the cockerel, 7 lbs. for the hen, 6½ lbs. for the pullet.

Egg-Laying Competitions in India *The Agricultural Journal, Vol. XVII., Calcutta, 1922.*—The first egg-laying competition in India was

held in 1920-21 by the United Provinces Poultry Association and proved such a success that it was decided to hold a similar competition every year. The first and second competitions were both limited to the three winter months. At the first, the winning hen was a Light Sussex, which laid 65 eggs in 92 days. Eighty hens took part in the second competition, and laid a total of 3320 eggs.

The Air Content of Butter. *O. Rahn and A. Storn, Molkerei Zeitung, Year 37, No. 23, Hildesheim, 1923.*—A high air content diminishes the keeping qualities and the delicacy of flavour of butter as the result of oxidation phenomena, the development of aerobic bacteria, etc. The authors determined the amount of air present in numerous samples of butter by means of an apparatus of their own invention. In the specimens shown at the Butter Exhibition held in 1922 in Schleswig-Holstein, they found field-made butter to contain on an average 4·42 cc. of air per 100 gm. (max. 7·20 cc., min. 1·74 cc.), while the figures obtained per 100 gm. of dairy-made butter were respectively 4·14, 4·50 and 0·97 cc. In the case of seventeen samples of butter sent to the Hamburg Butter Auktionen (sales by auction), the average maximum and minimum amount of air in 100 gm. of butter was 2·83-3·60 and 1·34 cc. The two series of results therefore agree fairly well. It is thus clear that the air content of different butters varies considerably; in the product of some farms it is particularly high, but generally speaking, field-made butter contains more air than dairy-made.

Injurious Action of Light on Butter. *F. Lauterwald, Molkereizeitung, Year 37, No. 17, Hildesheim, 1923.*—Basing his remarks on personal experience in the capacity of "Molkerei-instruktor" (Instructor to the Dairy and Dairy Products Industry), the author lays stress on the strong action of light upon butter, which is far more injurious than is stated by treatises on the subject, or believed by practical dairymen. Ten minutes exposure to brilliant sunshine is enough to give a sebaceous appearance and flavour to the finest sample of butter. He therefore advises the following technique:—the butter must be worked as soon as it comes from the churn, salted, made up, and at once taken into the dairy (which must be dark, damp and well ventilated): there it should be left to drip until the next day, again made up, put into barrels and the covers put on. The windows of the butter dairy must be red, yellow or grey. The custom of exposing butter for sale in the shop window should be abandoned, even if it is covered over to keep it dark. Also in the house the butter should be kept in yellow, red or grey glass vessels, and never in green, blue or colourless receptacles.

Braxy and its Prevention. *J. P. M'Gowan, Centralbl. f. Bakteriol. Parasit. u. Infectionskr., Jena, 1923.*—The author summarises the history of the investigation of braxy in sheep in this country and on the continent, and indicates the criticisms of continental investigators against the old idea that the disease was primarily an inflammation of the fourth stomach caused by an anærobic, motile, spore-bearing bacillus. This bacillus, isolated by Jensen and other workers, when fed to or inoculated into healthy sheep does not produce braxy; and the symptoms generally held to be the essential indications of braxy in dead sheep—distended body, blood-stained froth from the nostrils, regurgitated food and so on, with the associated internal changes—have been traced to rapid post-mortem putrefactive changes. The causal organism would appear to be the bacillus of hæmorrhagic septicæmia, which in limited numbers occurs in the respiratory passages of a large percentage of normal sheep, but which, when offered suitable conditions of low resistance, multiplies and gives rise to acute disease. Predisposing factors of low resistance are due to the greedy eating of grass or turnip leaves covered with hoar frost, or the subjection of healthy sheep to rapid and extreme day and night changes of temperature; and good results in preventing braxy follow from keeping the sheep, during the peculiarly snsceptible period from October to December, upon high grounds till the hoar frost has left the grass in the valleys, and in the low grounds preventing the access of sheep to succulent food while it is covered

with hoar frost. It is well known that greedy sheep in good condition are particularly liable to attack, and the author attributes the success of the pig-dung drench largely used, and of "vaccines" prepared from non-causal bacilli, to the fact that they seriously lower the condition of sheep, and so reduce their propensity to feed heavily on frosted herbage.

Rat Mites attacking Man. *F. C. Bishopp, U.S. Dept. Agr. Circ. 294, October 1923.*—In various parts of the world a blood-sucking mite parasitic on rats has been found, and further records are coming to hand to show that this parasite (*Liponyssus bacoti*), where rats become numerous, may become a serious discomfort to man. In the United States grocery and general stores, a railway general office building, a motion picture theatre, a music house, have recently illustrated the widespread nature of this pest, which seems to be confined to the business rather than the residential areas of cities, or, plainly, to the places where rats most abound in undisturbed freedom.

Both nymphs and adults of the mite attack man, causing some discomfort and itching by crawling actively and more by piercing the skin to suck blood. No specific disease accompanies the attacks, but irritation is generally acute for several hours after a bite. The presence of such a pest makes one more good reason why the presence of rats, and especially the brown rat, the most frequent host of the parasite, should not be tolerated.

Horse Bot-Fly in Queensland. *A. H. Cory, Queensland, Jour. Agr., 1923, p. 285.*—Methods recommended against the Horse Bot pest in Queensland endeavour both to prevent infection and to destroy the parasites in infected horses. In the first place the long hairs should be clipped off or singed from the nose, lips, jaws, shoulders and legs of horses to prevent the fly from settling and depositing its eggs. As a further precaution the horses should be groomed daily to remove adherent eggs, and the parts from which the hairs have been removed should be smeared daily with a mixture of linseed oil (20 parts) and turpentine or kerosene (1 part). Should horses become infested, medicines are said to be of little use till the summer months, when one of the following may be used: 2 oz. turpentine mixed in 1 pint milk, or 2 drachms carbolic acid, 2 oz. glycerine, 4 oz. water and 1 pint of milk. Either of these should be followed in a few hours by a dose of 1 pint raw linseed oil or 5 drachms aloes as a ball.

Harrows for Meadows. *G. Maurin, Journal d'Agriculture pratique, Vol. 39, No. 4, Paris, 1923.*—The extirpation of moss is an operation which is generally carried out in the months of February and March.

D. Lapparent makes the following statement: "In order to encourage the diffusion of the considerable reserves of nitrogen that meadows create in the soil, it is necessary to promote the introduction of air by means of mechanical work. If there is an excess of moss, it can be removed by sprinkling 200 to 400 kg. of sulphate of iron per hectare and using a special form of harrow with very closely set teeth."

For getting rid of moss the work of an ordinary harrow is very uneven, but much better results are given by what is known as chain harrows fitted with teeth in the form of colters and knives. The harrow consists of a collection of a certain number of components in the shape of a V with curved arms joined by means of rings. Each part is fitted with three teeth, one in front and two behind. The average dimension of the furrows made by the teeth is 21 mm.

The different parts of the harrow are joined in front to a connecting bar made of angle-iron, and behind to an iron bar which keeps them apart, though allowing the necessary amount of free movement. The teeth are in the shape of a colter on one side, but more blunted on the other, and have pointed ends so that they can be used for light harrowings of cereals at the end of the winter and for burying seeds scattered by hand over the surface of the soil.

School of Agricultural Mechanics at Mons (Belgium).—This school was founded in 1902 with the object of acquainting agriculturists with the most improved types of machines and teaching them how to handle, repair and

keep them in order. This school was the first of the kind every instituted either in Belgium or elsewhere. In 1907 the School passed under the management of the Province, which fitted it up with large plants. On November 4, 1920, the Provincial Council voted the credit necessary for opening a section for students learning to make agricultural machines. The workshop of this new section, which has an entirely modern equipment, started normal work on December 1, 1922, with a dozen students. The course of study and the apprenticeship last two-and-a-half years. Pupil machine-drivers are not admitted under sixteen years of age. They attend the courses and the repairs workshop for three months, and learn to drive and keep in order the machines by practical work in the open during the proper season. Particulars of the course and the regulations can be obtained from the "Direction de l'École de Mécanique agricole," 25 Boulevard des États-Unis, Mons, Belgique.

System of Protection of Tractors against Frost. *The Implement and Machinery Review.* - Serious accidents, such as the cracking of the radiators and the cylinder covers, have been caused by the freezing of the cooling water, with consequent expensive repairs and throwing the machine out of work for some time. Undoubtedly the simplest way to prevent such accidents would be to empty the radiator whenever there is danger of frost: this remedy, however, is dependent on the human factor and forgetfulness may prove costly.

Another expedient is to lower the freezing point of the cooling water by means of mixing with it glycerine, methylated spirit and chloride of lime.

These remedies also have drawbacks, because glycerine soils the tubes of the radiator and the pump, and decreases the power of cooling; methylated spirit evaporates gradually at 80° C., and chloride of lime alone gives good results.

The problem has now been solved mechanically by a French engineer, who has invented an apparatus by means of which the radiator is emptied automatically before the water is transformed into ice. A small apparatus formed of a copper worm and a chamber, closed below by a valve, communicates with the lowest point of the radiator. When the temperature of the air falls, the water in the worm, owing to its small volume and the high conductivity of the copper, cools more rapidly than that in the radiator, consequently the water in the worm is transformed into ice, while that in the radiator is still liquid. The increased volume of the mass of water, owing to its transformation into ice, causes a piston to advance, which operates the opening of the valve and consequently the emptying of the water from the radiator.

Experiments have shown that the apparatus works when the water in the radiator is still at 3° C., and that all the water can be emptied before transformation into ice occurs.

Poisonous Metals on Sprayed Fruits and Vegetables. *W. D. Lynch (Assistant Chemist), M'Donnell (Chief, Insecticide and Fungicide Laboratory), J. K. Haywood (Chief, Miscellaneous Division, Bureau of Chemistry), A. L. Quaintance (Entomologist, Fruit Investigations, Bureau of Entomology), M. B. Waite (Pathologist, Fruit Disease Investigations, Bureau of Plant Industry, U.S. Department of Agriculture). Bulletin No. 1027.*—Study undertaken to ascertain the amounts of arsenic, lead and copper remaining on fruits and vegetables treated with poisonous sprays.

Results of previous investigations are given, followed by a description of the experiments made with peaches, cherries, plums, apples, pears, grapes, cranberries, tomatoes, celery and cucumbers. Various methods of analysis were employed.

The following general conclusions may be drawn:—Comparatively large quantities of spray residues were found only when sprayed to excess, or in the case of late sprayings. In one instance 0·13 per cent. of lead was found on apples (dried fruit). The poison is liable to accumulate in the calyx. This indicates the importance of adhering strictly to the regulations recommended by the Bureaus of Entomology and Plant Industry. Practically all of the spray residues can be removed by peeling the fruit.

STATISTICS.

PRICES of AGRICULTURAL PRODUCE and FEEDING STUFFS in September, October and November 1923.

AVERAGE PRICES OF LIVE STOCK IN SCOTLAND.

(Compiled from Reports received from the Board's Market Reporters.)

Description.	September. 1st.	September. 2nd.	September. 3rd.	October. 1st.	October. 2nd.	October. 3rd.	November. 1st.	November. 2nd.	November. 3rd.
FAT STOCK :—									
CATTLE—	per cwt. l.w. s. d.	per cwt. l.w. s. d.	per cwt. l.w. s. d.	per cwt. l.w. s. d.	per cwt. l.w. s. d.	per cwt. l.w. s. d.	per cwt. l.w. s. d.	per cwt. l.w. s. d.	per cwt. l.w. s. d.
Aberdeen-Angus	64 9	58 11	38 6	65 2	59 10	39 2	69 9	63 9	52 5
Galloway	55 0	48 9	...	56 2	49 5	..	61 8	54 8	...
Ayrshire	56 0	44 0	38 0	56 0	43 7	36 5	61 6	49 6	39 6
Cross-bred (Shorthorn)	59 9	52 7	36 3	60 7	53 5	36 0	65 0	58 7	38 6
Blue Grey	..	..	...	...	...	...	...	...	...
Highland	60 1	...	...	61 7	58 6	...	62 5	59 5	...
	per lb. d.	per lb. d.	per lb. d.	per lb. d.	per lb. d.	per lb. d.	per lb. d.	per lb. d.	per lb. d.
VEAL CALVES ...	13	7	5	15	7	5	17	9	6
SHEEP—	under 60 lb. per lb. d.	60 lb. and upw'ds. per lb. d.	Ewes per lb. d.	under 60 lb. per lb. d.	60 lb. and upw'ds. per lb. d.	Ewes per lb. d.	under 60 lb. per lb. d.	60 lb. and upw'ds. per lb. d.	Ewes per lb. d.
Cheviot	15½	14½	11½	15½	14½	11¼	16	15¼	11¼
Half-bred	15½	14¼	10½	15¼	14¼	10	16	15	11
Blackface	15¾	14¼	11	15¼	13¾	10¾	16	15¼	11¼
Greyface	16	14½	8¼	15½	14¼	8¼	16¼	15	9¾
Down Cross	15¼	14¼	...	15¼	14¼	..	16¼	15¼	...
PIGS—	per stone. s. d.	per stone. s. d.	per stone. s. d.	per stone. s. d.	per stone. s. d.	per stone. s. d.	per stone. s. d.	per stone. s. d.	per stone. s. d.
Bacon Pigs	11 5	9 10	6 0	11 3	9 5	6 5	11 8	10 0	8 11
Porkers	12 5	10 8	6 5	11 9	10 3	6 4	12 1	10 7	10 0

AVERAGE PRICES OF LIVE STOCK IN SCOTLAND—*continued.*

Description.	September.			October.			November.		
	1st.	2nd.	3rd.	1st.	2nd.	3rd.	1st.	2nd.	3rd.
STORE STOCK:—									
STORE CATTLE—	per head. £ s.	per head. £ s.	per head. £ s.	per head. £ s.	per head. £ s.	per head. £ s.	per head. £ s.	per head. £ s.	per head. £ s.
Aberdeen-Angus:									
Yearlings	19 13	15 16	14 0	18 17	15 8	12 6	20 6	17 3	15 15
Two-year-olds ...	29 1	24 3	..	27 19	23 4	18 1	29 18	24 5	...
Galloway:									
Yearlings	16 0	...	...	17 8	15 0	..	16 10	...	...
Two-year-olds ...	24 15	19 8	...	25 8	18 10	...	24 15	20 0	...
Ayrshire:									
Yearlings	12 10	...	...	13 5	8 10	...	14 0	..	...
Two-year-olds ...	...	...	...	20 5	17 0	14 0	..	...	...
Cross-bred (Shorthorn):									
Yearlings	16 4	13 5	7 14	17 5	14 8	11 17	17 11	15 3	13 5
Two-year-olds ...	25 2	20 11	...	25 5	20 13	18 5	25 13	20 15	...
Blue Grey:									
Yearlings	...	...	...	...	...	..	..	...	...
Two-year olds ...	...	...	.		...	...	..	...	...
Highland:									
Yearlings	9 15	7 10	5 15	12 3	9 14	7 15	8 13	7 5	5 19
Two-year-olds ...	14 0	12 0	9 0	16 12	14 1	12 1	14 1	11 3	9 0
Three-year-olds ...	25 5	22 0	19 0	22 18	19 10	18 5	...	...	...
DAIRY COWS—									
Ayrshire:									
In Milk	34 10	25 18	16 6	36 3	26 17	16 13	32 13	26 10	14 2
Calvers	35 8	26 11	16 12	35 8	26 17	16 16	33 15	25 2	15 18
Shorthorn Crosses:									
In Milk	37 3	27 14	21 8	36 4	28 17	20 17	37 18	27 2	18 2
Calvers	36 10	27 1	19 7	38 0	27 6	19 9	37 7	28 0	19 4
STORE SHEEP—	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.
Cheviot Hoggs ...	77 2	69 8	56 6	72 0	64 1	44 7	...	47 0	...
Half-bred Hoggs ...	105 11	...	...	86 8	72 0	...	76 0	60 0	...
Blackface Hoggs ...	59 0	50 6	37 6	48 0	46 3	44 0	49 3	42 8	35 6
Greyface Hoggs ..	94 0	60 11	...	60 6	56 9	47 6	...	60 0	...
STORE PIGS—									
(6 to 10 weeks old)	36 5	23 0	...	32 6	20 11	...	32 9	20 4	...

AVERAGE PRICES OF DEAD MEAT AT DUNDEE, EDINBURG AND GLASGOW.

(Compiled from Reports received from the Board's Market Reporters.)

Description.	Quality.	September. Dundee.	September. Edinburgh.	September. Glasgow.	October. Dundee.	October. Edinburgh.	October. Glasgow.	November. Dundee.	November. Edinburgh.	November. Glasgow.
		per lb. d.	per lb. d.	per lb. d.	per lb. d.	per lb. d.	per lb. d.	per lb. d.	per lb. d.	per lb. d.
BEEF :—Home-fed—										
Bullock or Heifer ..	1	9	9½	10⅝	9¼	9	10⅞	10⅜	9⅞	11½
	2	8¾	8⅝	9⅜	8⅞	8	9¼	9⅞	8⅝	9⅝
Bull	1	7½	8¾	8⅛	7⅝	8¼	7⅝	8⅛	8½	8¼
	2	7	7⅞	6⅞	7⅜	7⅝	6⅞	7½	7½	7¼
Cow	1	6⅝	6⅝	7½	6¾	6½	7⅛	7⅛	6¾	7⅛
	2	6	6	6	6	5⅞	5⅜	6⅜	5⅛	5⅛
Irish—Bullock or Heifer	1	...	...	9	..	...	8⅝	9½		9⅛
	2	..	...	7¾	...	..	7⅞	9	...	6¾
Bull	1	...	...	7½	...	...	7¼	...	..	7¼
	2	...	...	6	...	...	6¼	...	...	5⅝
United States & Canadian—										
Killed at Birkenhead	1	..	..	.	..	..	...	...	..	8¼
	2	..	.	...	...	...	...	...	...	7⅝
,, Glasgow ...	1	..	..	9¼	..	...	8⅝	...	...	8½
	2	...	..	8	...	...	7⅝	...	...	7½
Argentine Frozen—										
Hind Quarters ...	1	...	6½	6¼	...	5⅞	5¾	..	5¼	5¾
Fore ,, ...	1	...	3½	3⅜	..	3⅝	3⅝	...	4⅛	3⅞
Argentine Chilled—										
Hind Quarters ...	1	...	6¼	7⅝	.	7⅛	6¾	...	6⅜	6⅝
	2	...	..	7	.	...	6¼	...	...	6¼
Fore ,, ...	1	...	3¾	3⅞	...	4¼	4¼	...	4⅜	4¼
	2	...	...	3⅝	.	..	4	...	...	4
Australian Frozen—										
Hind Quarters ...	1	...	5¾	...	...	5⅛	5¼	...	...	5¼
	2	...	...	...	...	...	5	...	...	5
Fore ,, ...	1	...	3½	...	...	3⅞	3½	...	...	3¾
	2	...	...	...	...	...	...	...	...	...
New Zealand Frozen—										
Hind Quarters ...	1	...	..	5⅜	...	5¼	5⅜	..	...	5½
	2	...	...	..	...	...	...	...	...	...
Fore ,, ...	1	...	...	3¼	...	3¼	3⅜	...	..	3½
	2	...	...	...	...	...	...	...	...	...
MUTTON :—										
Hoggs, Blackface ...	under 60 lb.	15¾	13¾	14⅞	15¼	13¼	14⅞	16	11¼	15½
	60 lb. & over	15	13	13⅞	15	12⅞	13¾	.	13⅛	14½
,, Cross	under 60 lb.	15¾	14⅜	14⅞	15¼	13¾	14⅞	16	14½	15½
	60 lb. & over	15	13½	13⅜	15	13⅜	13¼	..	13⅝	14⅜
Ewes, Cheviot ...	1	11	9⅝	10⅛	10¾	9⅝	9⅜	10⅞	9½	10¼
	2	10	...	9⅛	10	...	8⅝	..	...	8⅜
,, Blackface ...	1	11	...	9⅝	10¾	...	9¼	10⅞	8¼	9¾
	2	10	...	8	10	...	7¾	...	...	8⅜
,, Cross	1	9	8½	8⅜	8⅝	8¾	8¼	8⅜	8½	8¾
	2	8	...	6⅞	8	...	6⅞	...	...	7¾
Argentine Frozen ...	1	...	7⅛	6⅞	..	7⅛	6⅞	...	7¼	7¼
	2	...	...	...	...	...	...	...	...	...
Australian ,, ...	1	..	...	6	...	...	6⅜	...	..	6½
	2	...	...	5⅝	...	...	...	...	...	6
New Zealand ,, ...	1	...	...	6½	...	...	...	...	...	...
	2	...	...	5¾	...	...	...	...	...	...
LAMB :—Home-fed ...	1	16	15	15¼	15⅜	14¼	15¼	16	14	15⅜
	2	...	13¾	11¼	...	13¼	11¾	...	...	13⅛
New Zealand Frozen	1	...	11⅝	11¼	...	11½	11	...	11½	11
	2	...	...	9⅞	...	...	9½	...	...	9½
Australian ,, ...	1	...	...	9½	..	...	9½	...	...	9⅛
	2	...	...	9	..	...	9	...	...	8¼
Argentine ,, ...	1	...	9¼	...	...	8½	...	...	9½	...
	2	...	...	...	...	...	...	...	...	...

AVERAGE PRICES OF PROVISIONS AT GLASGOW.

(Compiled from Reports received from the Board's Market Reporters.)

Description.	Quality.	Sept. s. d.	Oct. s. d.	Nov. s. d.
BUTTER:				
Irish Creamery... per cwt.	1	193 6	197 7	197 0
" " (Unsalted) "	1	198 6	209 2	210 6
Danish ... ... "	1	205 0	210 0	216 3
" (Unsalted) "	1	214 6	218 0	224 9
New Zealand ... ... "	1	202 0	203 7	208 9
CHEESE: Cheddar ... "	1	129 0	132 0	134 6
	2	127 0	128 5	130 6
Dunlop ... ... "	1	125 6	126 5	124 6
	2	123 0	124 2	121 3
Canadian ... ... "	1	125 6	119 0	118 0
New Zealand (Coloured) "	1	127 6	123 7	120 6
New Zealand (White) "	1	129 6	123 7	118 0
BACON:				
Ayrshire (Rolled) ... "	1	164 0	151 7	144 0
Irish (Green) ... ... "	1	...	104 0	105 3
" (Dried or Smoked) "	1	...	124 0	127 6
" (Long Clear) ... "	1	142 9	124 7	116 3
Wiltshire (Green) ... "	1	...	...	...
" (Dried or Smoked) "	1	...	...	...
American, Long Clear Middles (Green) "	1	100 0	95 2	93 0
American, Short Clear Backs ... ... "	1	96 0	90 10	92 0
American, Bellies... "	1	94 0	90 10	94 0
" Sides ... "	1	...	...	...
" Cumberland Cut "	1	103 0	90 0	81 3
Canadian, Sides ... "	1	128 6	93 2	92 9
Danish, Sides ... "	1	133 0	100 10	101 6
HAMS:				
Irish (Smoked) per cwt.	1	197 0	159 10	146 0
American, Long Cut (Green) ... ... "	1	106 0	101 7	113 9
American, Short Cut "	1	99 6	95 5	114 0
	2	96 6	93 7	112 0
Canadian Long Cut "	1	...	...	113 6

Description.	Quality.	Sept. s. d.	Oct. s. d.	Nov. s. d.
EGGS:				
Country ... ... per doz.	1	2 8	3 3	3 9
	2	2 6	3 1	3 7
Irish ... ... per 120	1	20 2	23 10	30 8
	2	18 11	22 4	29 8
" (Cold Stored) "	1	17 0	17 7	18 9
	2	16 2	17 0	18 0
" (Duck) ... "	1	17 6	20 0	25 6
	2	...	...	...
American ... ... "	1	...	16 11	16 11
	2	...	...	16 6
Argentine ... ... "	1	...	...	19 5
	2	...	...	18 6
Canadian (Fresh) "	1	18 2	19 7	...
	2	...	...	...
" (Stored) "	1	...	18 8	19 6
	2	...	18 0	18 6
Chinese ... ... "	1	12 0	12 8	...
	2	11 0	11 6	...
Danish ... ... "	1	21 2	23 1	27 11
	2	19 11	21 6	26 3
Dutch ... ... "	1	17 6	20 10	26 3
	2	17 0	19 2	25 0
Dutch (Duck) ... "	1	...	...	20 0
Italian ... ... "	1	17 3	17 3	...
Lithuanian ... "	1	14 2	16 0	16 6
	2	...	15 0	15 0
Polish ... ... "	1	12 9	14 0	14 6
	2	11 3	13 6	14 0
Roumanian ... "	1	...	...	16 0
	2	...	...	15 0
Russian ... ... "	1	...	...	16 3
	2	...	...	15 9

AVERAGE PRICES OF POTATOES AT DUNDEE, EDINBURGH, AND GLASGOW.

(*Compiled from Reports received from the Board's Market Reporters.*)

Markets.	Quality.	First Earlies.	Second Earlies.	Late Varieties. Red Soils. Langworthy and Golden Wonder.	Late Varieties. Red Soils. Other.	Late Varieties. Other Soils. Langworthy and Golden Wonder.	Late Varieties. Other Soils. Other.
		per ton. £ s. d.	per ton. £ s. d.	per ton. £ s. d.	per ton. £ s. d.	per ton. £ s. d.	per ton. £ s. d.
SEPTEMBER.							
Dundee ...	First	...	5 10 0	...	...	...	...
	Second	...	...	...	...	...	...
Edinburgh ...	First	...	6 0 0	...	...	...	...
	Second	...	...	...	...	...	...
Glasgow ...	First	6 0 0	6 3 7	...	...	...	...
OCTOBER.							
Dundee ...	First	...	4 10 0	...	...	...	...
	Second	...	4 0 0	...	...	...	...
Edinburgh ...	First	...	5 8 4	...	...	8 0 0	5 7 6
	Second	...	...	...	...	...	...
Glasgow ..	First	...	5 15 7	...	...	7 17 6	5 11 0*
	First	...	...	...	...	...	5 11 0†
NOVEMBER.							
Dundee ...	First	...	...	...	...	...	5 7 6
	Second	...	...	...	...	...	...
Edinburgh ...	First	...	...	8 3 4	...	7 8 4	6 2 6
	Second	...	...	...	...	...	...
Glasgow ...	First	...	5 16 8	11 0 0	7 16 6	8 0 0	6 3 6*
	First	...	...	...	...	...	5 16 9†

* Kerr's Pink. † Arran Chief.

AVERAGE PRICES OF ROOTS, HAY, STRAW, AND MOSS LITTER, AT DUNDEE, EDINBURGH, AND GLASGOW.

(*Compiled from Reports received from the Board's Market Reporters.*)

Markets.	Quality.	Roots. Carrots.	Roots. Yellow Turnips.	Roots. Swedes.	Hay. Rye Grass and Clover.	Hay. Timothy.	Straw. Wheat.	Straw. Barley.	Straw. Oat.	Moss Litter.
		per ton. s. d.	per ton. s. d.	per ton. s. d.	per ton. s. d.	per ton. s. d.	per ton. s. d.	per ton s. d.	per ton. s. d.	per ton. s d.
		SEPTEMBER.								
† Dundee ...	1	...	17 6	..	120 0	...	70 0	...	68 9	...
	2	...	16 0	...	...	...	...	...	...	...
‡ Edinburgh	1	...	...	...	81 3	...	43 9	...	43 9	...
	2	...	...	...	...	...	...	...	...	...
Glasgow ...	1	...	...	...	...	...	...	...	...	25 0
	2	...	...	...	...	...	...	...	...	...
		OCTOBER.								
† Dundee ...	1	...	13 10	...	111 0	...	70 0	75 0	71 6	...
	2	...	...	...	90 0	...	...	...	...	...
‡ Edinburgh	1	...	...	...	84 6	...	44 0	39 6	44 6	...
	2	...	...	...	...	...	...	...	...	...
Glasgow ...	1	...	...	...	...	...	...	...	...	26 0
	2	...	...	...	...	...	...	...	...	...
		NOVEMBER.								
† Dundee ...	1	...	13 9	...	113 9	...	72 6	...	80 0	...
	2	...	13 0	...	102 6	...	...	...	...	...
‡ Edinburgh	1	...	...	...	91 3	...	47 6	45 0	50 8	...
	2	...	...	...	71 8	...	...	...	...	...
Glasgow ...	1	...	...	...	...	...	...	...	...	28 9
	2	...	...	...	...	...	...	...	...	...

† Quotations for Hay and Straw, baled and delivered.
‡ „ „ „ delivered loose in town.

Average Prices of Feeding Stuffs at Glasgow and Leith.

(Compiled from Reports received from the Board's Market Reporters.)

Description.	September.		October.		November.	
	Glasgow.	Leith.	Glasgow.	Leith.	Glasgow.	Leith.
	per ton. £ s. d.	per ton £ s. d.	per ton. £ s. d.	per ton. £ s. d.	per ton. £ s. d.	per ton. £ s. d.
Linseed Cake—						
Home	11 12 6	10 17 6	11 18 0	11 6 0	13 7 6	12 12 6
Foreign	10 15 0	...	...	10 17 6	12 6 3	11 16 11
Undecorticated Cotton Cake—						
Bombay (Home-manufactured)	7 0 0	6 12 6	7 9 0	7 0 0	7 7 6	6 18 9
Egyptian (Home-manufactured)	7 17 6	...	8 3 0	...	8 3 9	...
Coconut Cake ...	8 13 2	...	8 18 0	...	9 2 6	...
Groundnut Cake—						
Undecorticated ...	*9 1 3	...	*8 17 6	*9 5 0	*8 15 0	*9 5 0
Maize Germ Cake	10 6 3	...	9 15 0	...	10 3 9	...
Maize Germ Cake Meal	10 10 0	...	10 13 0	...	10 14 2	...
Palmnut Kernel Cake	6 18 2	...	7 3 0	...	7 5 0	...
Bean Meal ...	11 10 0	11 10 0	11 15 0	11 15 0	11 15 0	11 15 0
Maize Meal ...	9 11 3	†9 15 0	9 4 6	†9 3 0	9 8 2	†9 3 9
Locust Bean Meal	...	6 10 0	...	7 6 0	...	7 10 0
Rice Meal... ...	6 15 0	...	6 17 0	...	7 1 3	...
Locust Beans (Kibbled & Stoned)	...	...	...	6 10 0	...	6 10 0
Maize Gluten Feed (Paisley)	9 0 0	...	9 6 0	...	9 0 0	...
Maize	9 8 2	9 15 0	9 2 6	9 7 0	9 4 5	9 0 0
Oats, Canadian ...	9 15 8	...	9 16 0	...	9 11 11	...
" Home ...	...	9 15 0	...	9 8 0	9 3 9	9 0 0
Barley (Feeding) ...	8 5 0	9 5 0	8 5 6	8 9 0	9 0 8	8 5 0
Malt Culms ...	6 15 0	...	6 17 0	...	7 1 3	...
Distillery Mixed Grains—Dried ...	8 6 8	8 0 0	8 8 0	8 4 0	...	8 8 9
" Wet ...	...	1 15 0	...	1 15 0	...	1 15 0
Brewers' Grains—						
Dried	...	6 17 6	7 10 0	7 3 6	7 10 0	7 5 0
Wet	...	1 12 6	...	1 12 6	...	1 12 6
Distillery Malt Grains—Dried ...	7 18 2	...	8 0 0	...	7 18 9	...
Wheat—						
Middlings (Fine Thirds or Parings)	9 0 0	9 0 0	9 11 0	9 4 0	10 1 3	9 5 0
Sharps (Common Thirds)	6 15 0	7 0 0	7 0 0	7 4 0	7 8 9	7 5 0
Bran (Medium) ...	6 10 0	6 7 6	7 0 6	6 19 0	7 9 5	7 0 0
" (Broad) ...	6 15 0	7 5 0	7 8 0	7 13 0	7 15 0	7 15 0
Feeding Treacle ...	6 16 3	6 17 6	6 17 0	7 0 0	7 7 6	7 8 9
Fish Meal... ...	14 5 0	15 16 3	14 5 0	16 0 0	16 15 0	16 15 0

Oil and Albuminoids 40 to 42 per cent. † Imported Ground.

STATEMENT SHOWING THE ACREAGE UNDER EACH VARIETY OF POTATOES IN SCOTLAND IN 1923.

VARIETY.	Acres.
A. FIRST EARLIES.	
1. America	88
2. Arran Rose	88
3. Dargill Early	199
4. Immune Ashleaf	102
5. Snowdrop (including Witch Hill)	197
6. Beauty of Hebron (including Puritan) ...	136
7. Duke of York (including Midlothian Early and Victory)	2,389
8. Di Vernon *	27
9. Eclipse (including Sir John Llewelyn) ...	1,967
10. Epicure	9,410
11. May Queen	245
12. Myatt's Ashleaf Kidney	39
13. Ninetyfold	166
14. Sharpe's Express	2,047
15. Sharpe's Victor	85
16. Other First Earlies not specified above	126
Total First Earlies ...	17,311
B. SECOND EARLIES.	
17. Ally	779
18. Arran Comrade	1,258
19. Catriona *	22
20. Edzell Blue	375
21. Great Scot	9,681
22. Katie Glover	255
23. King George V.	448
24. K. of K.	72
25. Nithsdale	30
26. British Queen (including Pioneer, Macpherson, Maid of Auchterarder, Scottish Standard, English Beauty, etc.)	5,803
27. Royal Kidney (including Queen Mary)	158
28. Other Second Earlies not specified above	185
Total Second Earlies	19,066

VARIETY.	Acres.
C. MAINCROPS.	
29. Sutton's Abundance (including Admiral, Balmuir, Bloomfield, Culdees Castle, Kerr's New White, Laing's Prolific, Lomond, Twentieth Century, Osborne Seedling, Just in Time, etc.) ...	2,437
30. Arran Victory	668
31. Bishop	166
32. Champion	2,126
33. Crusader	1,084
34. Early Market	117
35. Golden Wonder (including Peacemaker) ...	12,403
36. Irish Queen	148
37. Kerr's Pink	10,988
38. Langworthy (including Maincrop and What's Wanted)	1,916
39. Lochar	254
40. Majestic	2,713
41. Rhoderick Dhu	633
42. Templar	98
43. Tinwald Perfection ...	2,372
44. White City (including Carnegie)	67
45. Arran Chief	21,021
46. Evergood	320
47. Field-Marshal	1,143
48. General	123
49. King Edward VII. (including Red King) ...	16,899
50. Northern Star (including Ajax, Allies, and Aeroplanes)	194
51. President (including Iron Duke and Scottish Farmer)	426
52. Up-to-Date (including Dalhousie, Factor, Glamis Beauty, Scottish Triumph, Stephen, Table Talk, Laing's Imperial, etc.)	3,594
53. Other Maincrops not specified above	815
Total Maincrops ...	82,725

TOTAL AREA RETURNED ... 119,102 ACRES.

NOTES.—(1) The Varieties marked * were not returned separately in 1922.
The following Varieties were returned separately in 1922, but are this year included as "not specified":—"Early Rose" (First Early), "Conquest" (including "Duchess") and "Windsor Castle" (Second Earlies), and "Burnhouse Beauty," "Dean" (Dr Wilson), "Dominion," "Irish Chieftain" and "Beauty of Bute" (including "John Bull"), (Maincrops).

(2) In the county of Inverness the districts of Skye, Harris, North and South Uist were excluded. In the county of Ross the Western and South-Western districts and the district of Lewis were excluded.

ABSTRACT OF AGRICULTURAL RETURNS FOR SCOTLAND, 1923.

Collected 4th June, 1923 (and comparison with 1922).

CROPS.

Distribution.	1923.	1922.	Increase.		Decrease.	
	Acres.	*Acres.*	*Acres.*	*Per Cent.*	*Acres.*	*Per Cent.*
Total Area (excluding Water)	19,069,683	19,069,683	..	..	..	..
Total Acreage under all Crops and Grass (*a*)	4,724,438	4,725,499	..	.	1,061	0·02
Arable Land	3,298,142	3,338,068	..	..	39,926	1·20
Permanent Grass (*a*) — For Hay . ..	152,857	114,804	8,053	5·56	..	.
Permanent Grass (*a*) — Not for Hay .	1,273,439	1,242,627	30,812	2·48		.
Permanent Grass (*a*) — Total.. ..	1,426,296	1,387,431	38,865	2·80	..	..
Wheat	58,789	65,251	..	..	6,462	9·90
Barley (including Bere)	158,657	157,020	1,637	1·04	.	..
Oats	968,211	988,392	.	..	20,181	2·04
Mixed Grain	1,237	1,036	201	19·40	.	.
Rye	6,406	6,694	..	..	288	4·30
Beans (to be harvested as Corn) .. .	3,803	3,692	111	3·01	..	..
Peas	469	460	9	1·96	..	..
Potatoes . ..	136,976	157,404	.	..	20,428	12·98
Turnips and Swedes .. .	409,642	404,112	5,530	1·37	..	
Mangolds . .	1,631	2,008	..		377	18·77
Cabbage	4,278	3,788	490	12·94	..	..
Rape	14,342	11,132	3,210	28·84	.	.
Vetches or Tares, for Seed	336	354	.	.	18	5·08
Vetches, Tares, Beans, Peas, Mashlum, etc., for Fodder .	10,230	9,564	666	6·96	..	..
Carrots	389	511	..	.	122	23·87
Onions	173	177	.	..	4	2·26
Flax	607	290	317	109·31	.	.
Small Fruit . ..	6,937	6,758	179	2·65	.	..
Rye-grass and other Rotation Grasses and Clover — For Hay .	414,527	431,601		..	17,074	3·96
Rye-grass and other Rotation Grasses and Clover — Not for Hay .	1,091,054	1,079,409	11,645	1·08	..	..
Rye-grass and other Rotation Grasses and Clover — Total	1,505,581	1,511,010	..	.	5,429	0·36
Other Crops	2,093	2,023	70	3·46		..
Bare Fallow	7,355	6,392	963	15·07	..	..

LIVE STOCK.

Distribution.	1923.	1922.	Increase.		Decrease.	
	No.	*No.*	*No.*	*Per Cent.*	*No.*	*Per Cent.*
Horses used for Agricultural purposes (including Mares for Breeding)	138,803	139,411	..	.	608	0·44
Unbroken Horses (including Stallions) — One year and above	34,336	39,626	.	..	5,290	13·35
Unbroken Horses (including Stallions) — Under one year .	8,281	9,814		..	1,533	15·62
Total	181,420	188,851	.	..	7,431	3·93
Other Horses	22,413	22,918		..	505	2·20
Total of Horses	203,833	211,769	..	..	7,936	3·75
Cows in Milk	361,742	358,943	2,799	0·78	.	..
Cows in Calf, but not in Milk	42,132	44,695	..	..	2,563	5·73
Heifers in Calf	51,489	48,593	2,896	5·96	..	..
Bulls being used for Service	17,530	18,386	..	..	856	4·66
Other Cattle:—Two years and above ..	225,441	199,242	26,199	13·15	..	..
„ „ One year and under two ..	265,387	250,157	15,230	6·09	..	..
„ „ Under one year	229,869	226,791	3,078	1·36	..	..
Total of Cattle .. .	1,193,590	1,146,807	46,783	4·08	..	..
Ewes kept for Breeding	2,903,307	2,872,529	30,778	1·07	..	..
Rams to be used for Service in 1923 . ..	79,770	79,763	7	0·01	..	..
Other Sheep:—One year and above.. ..	1,002,436	971,618	30,818	3·17	..	..
„ „ Under one year	2,800,210	2,760,187	40,023	1·45	..	..
Total of Sheep	6,785,723	6,684,097	101,626	1·52	..	..
Sows kept for Breeding	24,485	18,407	6,078	33·02	..	..
Boars being used for Service	2,625	2,151	474	22·04	..	..
Other Pigs	158,917	130,326	28,591	21·94	..	..
Total of Pigs	186,027	150,884	35,143	23·29	..	..

(*a*) Excluding Mountain and Heath Land used for grazing (9,678,206 acres in 1923).

ACREAGE under WHEAT, BARLEY (including Bere), and OATS in each COUNTY on 4th June 1923, with COMPARISON for 1922.

COUNTIES.	**Wheat.**		**Barley (including Bere).**		**Oats.**	
	1923.	1922.	1923.	1922.	1923.	1922.
	Acres.	*Acres.*	*Acres.*	*Acres.*	*Acres.*	*Acres.*
ABERDEEN . .	31	54	21,521	21,414	187,509	190,641
ARGYLL . . .	...	2	1,325	1,152	16,415	17,205
AYR . . .	1,081	983	318	344	43,306	42,929
BANFF . . .	6	3	7,848	7,864	47,933	48,915
BERWICK . .	1,550	3,053	16,013	16,296	29,837	30,481
BUTE . . .	7	7	12	7	4,985	5,056
CAITHNESS . .	...	...	691	650	30,252	31,330
CLACKMANNAN .	411	432	182	176	3,204	3,175
DUMBARTON . .	644	662	36	16	7,434	7,658
DUMFRIES . .	79	96	392	292	39,600	41,194
EAST LOTHIAN .	4,953	6,272	14,618	14,037	17,469	17,716
FIFE . . .	12,821	13,786	14,070	13,518	44,177	44,955
FORFAR . . .	11,000	11,119	18,284	18,696	56,304	56,080
INVERNESS . .	18	48	5,238	5,077	30,042	31,026
KINCARDINE . .	1,193	1,482	10,425	9,567	30,020	30,555
KINROSS . .	177	219	172	154	7,019	7,264
KIRKCUDBRIGHT .	10	18	61	39	24,070	24,900
LANARK . .	2,317	2,459	129	134	38,759	40,475
LINLITHGOW . .	2,580	2,938	2,035	1,841	11,189	11,375
MIDLOTHIAN . .	5,646	6,722	4,841	4,653	21,709	21,818
MORAY . . .	535	785	9,730	9,696	24,419	24,692
NAIRN . . .	...	18	2,301	2,330	6,134	6,224
ORKNEY . .	...	...	3,471	3,510	33,698	34,496
PEEBLES . .	...	8	152	310	6,493	6,923
PERTH . . .	8,455	8,313	4,251	3,973	71,675	73,412
RENFREW . .	1,975	1,952	19	9	10,209	10,649
ROSS & CROMARTY	574	753	8,806	8,935	31,184	31,388
ROXBURGH . .	478	767	9,104	9,581	26,503	26,929
SELKIRK . .	8	15	255	338	3,956	4,135
SHETLAND . .	...	...	651	726	6,464	6,740
STIRLING . .	2,194	2,194	998	1,024	18,549	19,169
SUTHERLAND . .	...	...	445	448	7,824	8,142
WIGTOWN . .	46	91	263	213	29,870	30,745
TOTAL .	58,789	65,251	158,657	157,920	968,211	988,392

ACREAGE under BEANS, POTATOES, and TURNIPS and SWEDES in each COUNTY on 4th June 1923, with COMPARISON for 1922.

COUNTIES.	Beans.*		Potatoes.		Turnips and Swedes.	
	1923.	1922.	1923.	1922.	1923.	1922.
	Acres.	*Acres.*	*Acres.*	*Acres.*	*Acres.*	*Acres.*
ABERDEEN . .	23	17	7,355	8,049	82,273	81,748
ARGYLL . .	27	22	3,123	3,265	5,261	5,372
AYR . .	290	288	8,465	9,895	7,674	7,368
BANFF . .	31	29	1,734	1,848	20,171	20,106
BERWICK . .	181	263	2,470	2,983	21,469	21,466
BUTE . .	19	19	1,075	1,166	1,370	1,335
CAITHNESS .	.	..	1,323	1,360	11,619	11,515
CLACKMANNAN	270	219	381	449	797	781
DUMBARTON .	13	28	2,282	2,762	1,486	1,393
DUMFRIES .	1	.	3,534	4,292	15,651	15,091
EAST LOTHIAN	88	61	7,511	8,228	12,580	12,660
FIFE . .	334	243	15,901	18,565	21,719	20,968
FORFAR . .	52	18	16,610	19,564	31,109	29,741
INVERNESS .	2	.	5,218	5,298	9,290	9,297
KINCARDINE .	29	31	4,134	5,136	15,569	15,263
KINROSS . .	1	3	1,179	1,449	2,449	2,324
KIRKCUDBRIGHT	5	2	1,376	1,589	9,999	10,165
LANARK . .	...	16	5,279	6,237	9,808	9,429
LINLITHGOW .	55	29	2,381	2,699	3,359	3,262
MIDLOTHIAN .	...	3	6,333	7,248	9,727	9,631
MORAY . .	15	20	1,502	1,717	13,892	13,652
NAIRN . .	...	1	283	278	3,855	3,765
ORKNEY . .	...	...	2,271	2,331	13,692	13,632
PEEBLES . .	...	..	314	417	3,033	3,124
PERTH . .	769	730	16,071	19,865	25,376	24,348
RENFREW .	65	55	2,928	3,464	2,125	2,125
ROSS AND CROMARTY .	5	...	6,889	7,067	14,197	14,233
ROXBURGH .	93	88	1,112	1,275	17,438	17,680
SELKIRK . .	...	...	156	176	2,050	2,145
SHETLAND .	...	...	2,167	2,253	993	1,008
STIRLING. .	1,381	1,441	2,865	3,555	3,919	3,932
SUTHERLAND .	...	...	1,193	1,208	2,834	2,826
WIGTOWN .	54	66	1,561	1,716	12,858	12,727
TOTAL .	3,803	3,692	136,976	157,404	409,642	404,112

* To be harvested as corn.

ACREAGE under RYE-GRASS and other ROTATION GRASSES and CLOVER, and under PERMANENT GRASS in each COUNTY on 4th June 1923, with COMPARISON for 1922.

COUNTIES.	Rye-grass and other Rotation Grasses and Clover.				Permanent Grass.			
	For Hay.		Not for Hay.		For Hay.		Not for Hay.	
	1923.	1922.	1923.	1922.	1923.	1922.	1923.	1922.
	Acres.	*Acres.*	*Acres.*	*Acres.*	*Acres.*	*Acres.*	*Acres.*	*Acres.*
ABERDEEN .	51,840	54,459	235,380	234,985	693	724	36,740	31,530
ARGYLL . .	11,924	12,405	15,861	15,338	15,063	14,199	58,233	57,936
AYR . .	27,354	28,704	52,389	51,681	22,286	20,765	147,155	147,854
BANFF . .	10,067	10,807	58,832	57,354	361	283	10,037	9,797
BERWICK .	11,721	12,257	48,422	47,089	2,130	2,154	53,504	52,053
BUTE . .	2,291	2,614	5,720	6,060	317	403	9,437	8,542
CAITHNESS .	9,704	10,130	26,593	25,621	671	603	25,526	25,357
CLACKMANNAN	1,359	1,525	1,836	1,845	1,021	944	5,672	5,598
DUMBARTON .	5,650	5,827	5,918	5,881	2,107	1,697	20,514	20,500
DUMFRIES .	20,525	21,158	47,915	48,357	18,169	18,381	98,591	95,090
EAST LOTHIAN	9,828	10,026	16,634	16,390	765	717	22,008	20,918
FIFE . .	27,800	27,805	30,519	31,412	3,431	3,209	68,178	65,305
FORFAR . .	22,585	24,423	61,192	59,173	1,568	1,224	24,045	23,174
INVERNESS .	11,191	11,714	21,975	21,145	8,239	7,301	56,136	55,808
KINCARDINE .	13,751	14,053	33,587	32,411	172	215	8,831	8,854
KINROSS . .	3,186	3,576	7,541	7,379	969	721	10,468	10,093
KIRKCUDBRIGHT	10,187	10,886	52,012	51,592	12,526	11,726	69,961	69,405
LANARK . .	33,110	34,148	36,994	37,063	12,226	11,331	103,046	102,109
LINLITHGOW .	7,249	7,202	5,314	5,383	1,281	980	20,948	20,696
MIDLOTHIAN .	11,805	11,839	15,315	15,839	2,169	2,007	39,801	38,610
MORAY . .	6,086	5,908	34,367	33,970	173	265	6,742	6,857
NAIRN . .	1,644	1,966	9,555	9,166	62	30	1,730	1,781
ORKNEY . .	8,897	9,603	30,630	29,616	417	488	14,028	13,776
PEEBLES . .	2,620	2,587	11,631	11,363	1,282	1,271	24,288	23,764
PERTH . .	34,172	36,682	60,598	61,634	11,232	10,511	87,807	80,207
RENFREW .	9,443	9,844	6,993	7,235	6,704	6,335	42,619	41,990
ROSS AND CROMARTY .	13,300	13,688	33,599	33,293	2,477	2,432	24,968	23,783
ROXBURGH .	10,113	10,033	46,363	46,165	6,707	6,937	57,616	55,890
SELKIRK .	1,260	1,393	7,375	6,728	1,815	1,796	12,549	13,087
SHETLAND .	1,312	1,284	705	671	1,759	1,725	10,466	11,172
STIRLING .	11,614	12,076	9,757	9,552	7,087	7,121	52,314	50,794
SUTHERLAND .	4,476	4,531	5,544	5,699	1,512	1,410	6,774	6,169
WIGTOWN .	6,463	6,448	53,988	52,319	5,466	4,899	42,707	44,128
TOTAL .	414,527	431,601	1,091,054	1,079,409	152,857	144,804	1,273,439	1,242,627

NUMBER of HORSES, CATTLE, SHEEP, and PIGS in each COUNTY on 4th June 1923, with COMPARISON for 1922.

COUNTIES.	Horses.†		Cattle.		Sheep.		Pigs.	
	1923.	1922.	1923.	1922.	1923.	1922.	1923.	1922.
	No.	*No.*	*No.*	*No*	*No.*	*No.*	*No.*	*No.*
ABERDEEN .	27,669	29,524	173,105	165,316	204,126	203,484	21,030	15,401
ARGYLL . .	5,897	6,199	55,325	56,412	768,492	755,842	5,046	4,274
AYR . .	9,559	10,070	109,414	111,784	350,105	348,994	15,651	12,388
BANFF . .	8,269	8,776	44,176	43,665	61,791	61,965	4,751	3,734
BERWICK .	4,539	4,528	21,184	15,703	325,698	317,245	4,956	4,968
BUTE . .	1,289	1,333	9,311	9,639	39,238	38,597	922	671
CAITHNESS .	5,389	5,631	21,595	20,127	148,733	147,513	2,515	2,390
CLACKMANNAN	761	802	3,439	3,422	13,424	12,783	610	645
DUMBARTON .	1,765	1,886	13,541	13,632	66,836	65,799	1,442	1,112
DUMFRIES .	7,322	7,570	68,793	67,725	547,770	539,879	12,045	9,004
EAST LOTHIAN	3,331	3,361	13,320	8,579	130,362	123,557	3,567	3,125
FIFE . .	9,458	9,487	42,495	38,089	96,773	91,978	9,803	8,205
FORFAR . .	8,793	8,916	46,692	40,204	168,672	165,927	9,131	6,916
INVERNESS .	8,066	8,183	46,943	47,147	501,675	496,201	2,267	1,829
KINCARDINE .	4,557	4,792	24,817	22,641	44,913	39,348	3,802	2,507
KINROSS . .	1,175	1,274	6,107	5,520	32,188	29,079	933	725
KIRKCUDBRIGHT	5,260	5,383	56,839	55,721	363,550	363,356	13,465	11,825
LANARK . .	7,992	8,334	72,256	72,115	222,514	225,934	9,134	7,005
LINLITHGOW .	2,206	2,250	11,851	11,350	15,694	14,012	1,865	1,732
MIDLOTHIAN .	3,657	3,853	16,972	16,029	170,234	170,632	12,637	11,477
MORAY . .	4,666	4,911	22,831	21,267	46,068	44,754	3,235	2,232
NAIRN . .	1,301	1,370	6,419	6,079	13,960	13,744	786	877
ORKNEY . .	6,399	6,562	32,285	31,307	34,459	34,113	2,043	1,841
PEEBLES . .	1,018	1,048	6,703	6,588	200,945	200,738	622	423
PERTH . .	12,014	12,739	66,112	61,806	592,700	582,841	11,326	8,566
RENFREW .	2,774	2,942	25,506	25,483	38,038	36,796	3,723	2,981
ROSS AND CROMARTY .	6,465	6,754	40,134	38,438	277.841	265,111	4,312	3,433
ROXBURGH .	3,787	3,897	21,608	18,630	533,619	526,252	3,510	3,239
SELKIRK . .	560	582	3,395	3,327	183,497	183,055	771	600
SHETLAND .	2,760	3,029	12,788	13,583	149,529	132,901	402	531
STIRLING .	4,571	4,649	31,619	30,435	117,094	114,195	3,005	2,390
SUTHERLAND .	2,197	2,252	10,527	10,451	207,146	200,960	843	731
WIGTOWN .	5,954	5,964	55,488	54,593	118,039	116,512	15,877	13,107
TOTAL .	181,420	188,851	1,193,590	1,146,807	6,785,723	6,684,097	186,027	150,884

† Horses used for agricultural purposes, mares for breeding, and unbroken horses (including stallions). "Other horses on agricultural holdings" are not included; the total of these for Scotland is given in the summary table on p. 1.

ACREAGE of CROPS and NUMBER of LIVE STOCK in each COUNTY DISTRICT of SCOTLAND on 4th June 1923.

County and District of County.		Wheat	Barley (including Bere).	Oats.	Beans.*	Potatoes.	Turnips and Swedes.	Rye-grass and other Rotation Grasses & Clover. For Hay.	Rye-grass and other Rotation Grasses & Clover. Not for Hay.	Permanent Grass. For Hay.	Permanent Grass. Not for Hay.	Horses†	Cattle.	Sheep.	Pigs.
		Acres.	Acres.	Acres.	Acres.	Acres.	Acres.	Acres.	Acres.	Acres.	Acres.	No.	No.	No.	No.
ABERDEEN	Aberdeen	2	6,069	17,173	..	1,740	9,743	7,577	26,323	2	2,236	3,238	19,565	10,118	4,467
	Alford	..	861	16,754	.	338	7,827	5,208	21,630	166	5,507	2,470	16,173	36,475	816
	Deer	..	2,094	43,471	18	1,930	16,797	11,652	47,158	161	9,342	6,065	39,260	29,942	4,973
	Deeside	..	1,943	14,911	.	466	7,151	5,831	18,714	48	4,946	2,571	14,591	46,248	1,179
	Ellon	28	3,070	28,018	.	986	12,355	7,934	34,948	116	3,951	3,544	24,798	25,829	2,591
	Garioch	1	3,484	23,299	..	702	10,853	6,103	31,200	78	3,696	3,641	21,868	12,718	2,778
	Huntly	..	1,119	15,824	2	363	6,410	2,741	21,327	73	5,320	2,420	18,320	32,056	1,298
	Turriff	..	2,881	28,059	3	830	11,137	4,794	34,080	49	1,742	3,920	23,530	10,745	2,933
ARGYLL	Ardnamurchan	..	..	418	.	250	45	671	110	1,211	1,752	161	3,019	65,174	63
	Cowal	..	2	1,329	.	262	425	1,020	1,067	1,912	5,766	402	4,372	141,049	257
	Islay	..	5	4,062	..	592	1,227	2,866	2,742	1,663	18,243	1,220	9,975	73,785	796
	Kintyre	..	651	4,542	27	416	2,167	1,541	9,442	1,301	11,684	1,530	13,977	126,315	2,496
	Lorn	..	8	2,209	..	649	622	2,540	725	3,890	5,934	872	8,896	175,947	658
	Mid-Argyll .. .	..	1	1,628	..	363	506	1,713	1,324	2,690	7,874	650	7,028	111,374	394
	Mull	..	658	2,227	..	591	269	1,573	451	2,396	6,980	1,062	8,058	74,848	382
AYR	Ayr	161	33	11,433	147	1,625	1,842	7,449	15,710	6,712	37,956	2,270	29,259	102,640	4,640
	Carrick	93	250	10,283	105	3,546	2,977	4,977	14,261	3,653	33,131	2,414	22,685	182,292	4,027
	Kilmarnock . ..	400	11	10,998	11	912	1,400	8,328	12,491	6,031	40,090	2,404	31,187	27,545	5,009
	Northern	427	24	10,597	27	2,382	1,455	6,606	9,927	5,890	35,978	2,471	26,283	37,628	1,975
BANFF	Banff	..	6,458	26,702	30	1,219	11,955	5,601	33,700	72	2,624	4,688	26,504	16,653	3,450
	Keith	6	1,390	21,231	1	515	8,216	4,466	25,132	289	7,413	3,581	17,672	45,138	1,301
BERWICK	East	751	5,954	9,231	97	1,284	6,956	3,947	14,335	813	15,643	1,484	6,356	79,792	2,437
	Middle	673	7,858	10,123	76	776	8,181	5,061	14,170	776	19,412	1,779	8,764	114,604	1,576
	West	126	2,201	10,483	8	410	6,332	2,713	19,917	541	18,449	1,276	6,064	131,302	943
BUTE	Arran	2	11	2,395	19	629	473	1,150	2,272	228	4,698	624	4,536	31,168	497
	Bute and Cumbrae ..	5	1	2,590	.	446	897	1,141	3,448	89	4,739	665	4,775	8,070	425
CAITHNESS (Not divided)		..	691	30,252	..	1,323	11,619	9,704	26,593	671	25,526	5,389	21,595	148,733	2,515
CLACKMANNAN (Not divided) ..		411	182	3,204	270	381	797	1,379	1,836	1,021	5,672	761	3,439	13,424	610
DUMBARTON	Eastern	517	5	3,926	7	1,148	725	3,043	2,486	860	9,448	935	5,994	10,059	873
	Western	127	31	3,508	6	1,134	761	2,607	3,432	1,247	11,066	830	7,547	56,777	560
DUMFRIES	Annan	5	188	12,891	..	1,148	5,010	5,981	13,889	2,500	16,310	2,162	15,645	43,751	3,497
	Dumfries	70	77	9,566	..	1,143	3,467	4,103	10,973	2,076	15,840	1,587	13,288	48,646	2,882
	Langholm	..	12	2,849	..	189	990	1,446	2,728	2,883	8,056	526	5,442	123,753	706
	Lockerbie	4	115	8,722	..	614	3,768	4,880	12,145	5,763	26,254	1,752	18,458	146,586	2,084
	Thornhill	..	..	6,072	1	440	2,418	4,115	8,185	4,947	32,131	1,295	15,960	185,034	2,876

* To be harvested as corn.

† See note on p. 5.

ACREAGE of CROPS and NUMBER of LIVE STOCK in each COUNTY DISTRICT of SCOTLAND on 4th June 1923.

County and District of County.		Wheat	Barley (including Bere).	Oats.	* Beans.	Potatoes.	Turnips and Swedes.	Rye-grass and other Rotation Grasses & Clover.		Permanent Grass.		† Horses	Cattle.	Sheep.	Pigs.
								For Hay.	Not for Hay.	For Hay.	Not for Hay.				
		Acres.	Acres.	Acres.	Acres.	Acres.	Acres.	Acres.	Acres.	Acres.	Acres.	No.	No.	No.	No.
EAST LOTHIAN	Eastern	1,359	5,938	5,608	49	3,213	4,709	3,154	6,268	404	8,767	1,208	4,648	64,326	1,093
	Western	3,594	8,680	11,861	39	4,298	7,871	6,674	10,366	361	13,241	2,123	8,672	66,086	2,474
FIFE	Cupar	4,027	4,545	14,689	30	5,671	7,630	7,878	13,238	377	14,849	2,780	11,373	37,579	2,571
	Dunfermline	1,259	749	7,554	158	1,690	2,654	4,676	3,704	1,213	21,435	1,658	9,307	21,077	1,891
	Kirkcaldy	2,730	2,591	9,835	..	3,538	4,388	6,754	5,433	890	14,462	2,158	10,111	17,855	2,869
	St. Andrews	4,805	6,185	12,090	146	5,002	7,047	8,512	8,144	951	17,432	2,912	11,704	20,262	2,472
FORFAR	Arbroath	2,976	4,739	10,045	14	3,931	6,479	4,594	10,457	334	2,944	1,815	9,106	8,182	1,455
	Brechin	2,537	6,144	17,974	15	3,909	9,823	7,142	19,124	458	6,652	2,545	13,896	61,724	2,380
	Dundee	3,031	2,913	10,157	21	4,271	5,896	4,672	9,808	303	3,957	1,739	9,798	15,685	2,691
	Forfar	2,456	4,488	18,128	2	4,490	8,911	6,177	21,803	473	10,492	2,694	14,390	83,081	2,605
INVERNESS	Inverness	..	2,116	7,059	..	439	4,269	2,727	11,011	235	4,413	1,576	6,525	39,007	937
	Aird	18	186	5,958	2	481	2,655	2,925	5,511	503	4,618	1,129	6,307	40,988	921
	Badenoch	..	97	4,149	..	182	1,702	2,851	4,376	1,252	8,699	769	4,712	89,575	256
	Lochaber	..	2	1,165	.	465	258	1,341	352	2,127	2,907	416	5,041	141,376	131
	Skye	..	4	5,472	..	1,302	305	1,586	590	2,721	5,062	1,072	9,926	130,932	12
	Harris, N. & S. Uist	..	2,883	6,239	.	2,349	101	261	135	1,401	30,437	3,104	14,432	59,797	10
KINCARDINE	Laurencekirk	334	2,353	9,310	.	1,374	4,404	3,683	8,738	57	2,048	1,112	5,869	15,215	929
	Lower Deeside	..	1,320	3,366	..	768	1,767	2,155	3,585	8	319	614	3,200	879	678
	St. Cyrus	758	2,209	5,928	23	907	3,059	2,595	5,591	63	2,346	839	3,793	9,503	558
	Stonehaven	106	3,030	7,740	6	742	4,137	3,717	9,697	23	3,002	1,270	7,889	12,269	1,108
	Upper Deeside	..	1,513	3,676	..	253	2,202	1,601	5,976	21	1,116	722	4,006	7,047	529
KINROSS (Not divided)		177	172	7,019	1	1,179	2,449	3,186	7,541	969	10,468	1,175	6,107	32,188	933
KIRKCUDBRIGHT	Eastern	3	11	10,272	..	896	4,092	4,414	16,185	8,479	23,842	2,017	19,525	63,026	3,932
	Northern	..	.	1,857	..	130	773	837	3,616	2,817	9,803	584	5,743	142,141	966
	Southern	7	48	9,8[illegible]9	2	267	4,317	4,010	28,440	4,684	26,488	2,190	25,854	76,446	7,984
	Western	..	2	2,042	3	83	817	926	3,771	1,546	9,828	469	5,717	81,937	583
LANARK	Lower Ward	1,008	45	4,007	..	1,226	638	3,372	1,864	2,436	6,431	835	4,571	1,089	2,912
	Middle Ward	1,279	66	17,241	..	2,099	8,306	17,772	12,442	5,501	52,178	3,936	36,887	27,553	3,765
	Upper Ward	35	18	17,511	..	1,954	5,864	11,966	22,688	4,289	44,437	3,221	30,798	193,872	2,457
LINLITHGOW	Bathgate	356	279	5,477	..	574	1,218	3,558	2,582	802	13,397	1,095	6,847	6,935	468
	Linlithgow	2,224	1,756	5,712	55	1,807	2,141	3,691	2,782	479	7,551	1,111	5,004	8,759	1,397
MIDLOTHIAN	Calder	1,561	767	6,079	..	1,706	1,728	3,755	1,839	587	13,810	1,088	5,678	35,179	1,770
	Gala-Water	244	1,321	5,881	..	359	3,099	1,719	9,670	512	14,834	735	3,382	93,363	393
	Lasswade	1,423	1,714	5,961	..	1,725	2,819	3,544	3,571	821	7,360	1,048	3,997	34,172	1,305
	Suburban	2,418	1,039	3,788	..	2,543	1,481	2,787	235	249	3,797	786	3,915	7,520	9,169
MORAY (Not divided)		535	9,730	24,419	15	1,502	13,892	6,086	34,367	173	6,742	4,666	22,831	46,068	3,235

* To be harvested as corn.

† See Note on p. 5.

ACREAGE of CROPS and NUMBER of LIVE STOCK in each COUNTY DISTRICT of SCOTLAND on 4th June 1923.

County and District of County.	Wheat	Barley (including Bere).	Oats.	* Beans.	Potatoes.	Turnips and Swedes	Rye-grass and other Rotation Grasses & Clover. For Hay.	Rye-grass and other Rotation Grasses & Clover. Not for Hay.	Permanent Grass. For Hay.	Permanent Grass. Not for Hay.	† Horses	Cattle.	Sheep.	Pigs.
	Acres.	Acres.	Acres.	Acres.	Acres.	Acres.	Acres.	Acres.	Acres.	Acres.	No.	No.	No.	No.
NAIRN (Not divided)	..	2,301	6,134	..	283	3,855	1,644	9,555	62	1,739	1,301	6,419	13,960	780
ORKNEY — Mainland	..	1,066	18,704	..	1,195	7,062	3,850	16,394	292	7,331	3,526	16,832	13,509	1,072
ORKNEY — North Isles	..	2,087	10,039	..	746	4,796	2,280	10,415	63	5,698	2,088	11.107	15,464	747
ORKNEY — S. Ronaldshay & Walls	..	318	4,955	..	330	1,834	1,267	3,821	62	999	790	4,346	5,396	224
PEEBLES (Not divided)	..	152	6,498	..	314	3,033	2,620	11,631	1,282	24,288	1,018	6,703	200,945	622
PERTH — Blairgowrie	2,311	1,965	16,144	1	4,404	6,629	6,727	15,208	497	13,270	2,401	12,801	55,995	2,726
PERTH — Central	801	139	15,756	1	3,270	4,886	7,295	18,875	1,663	17,299	2,485	12,324	122,392	2,390
PERTH — Highland	18	59	6,851	..	777	2,634	4,620	6,269	2,361	15,062	1,406	9,000	187,912	1,504
PERTH — Perth	4,872	1,858	22,484	295	6,113	8,954	10,046	17,434	2,121	24,537	3,461	18,915	54,145	3,440
PERTH — Western	453	230	10,440	472	1,507	2,273	5,484	7,826	4,690	17,639	2,261	13,072	172,256	1,266
RENFREW — First or Upper	1.301	..	4,497	20	1,197	996	4,686	2,383	4,193	21,489	1,292	12,705	17,198	2,078
RENFREW — Second or Lower.. ..	674	19	5,712	45	1,731	1,129	4,757	4,610	2,511	21,130	1,482	12,801	20,840	1,645
ROSS & CROMARTY — Black Isle..	..	2,738	6,728	..	723	4,142	3,185	9,621	126	1,403	1,425	5,962	13,472	1,194
ROSS & CROMARTY — Easter Ross	547	1,970	9,710	..	1,294	5,422	4,428	12,794	322	5,958	1,898	9,178	66,310	1,982
ROSS & CROMARTY — Mid Ross	27	1,517	9,090	..	767	4,267	4,091	10,640	403	5,885	1,774	8,868	71,117	1,123
ROSS & CROMARTY — S.-W. and Western ..	..	12	1,942	5	636	210	1,486	424	1,489	1,950	388	4,609	71,496	53
ROSS & CROMARTY — Lewis	..	2,569	3,714	..	3,469	156	160	120	137	9,772	980	11,522	55,446	10
ROXBURGH — Hawick & Liddesdale ..	7	66	3,634	5	167	1,937	1,812	4,843	3,581	13,847	615	4,987	177,532	552
ROXBURGH — Jedburgh	47	1,729	8,157	2	248	4,768	2,684	16,189	1,599	16,898	1,136	6,246	150,936	888
ROXBURGH — Kelso	387	6,069	8,567	86	518	7,066	3,649	15.413	919	13,926	1,277	6,678	137,943	1,328
ROXBURGH — Melrose	87	1,240	6,145	..	184	3,667	1,968	9,968	608	13,445	759	3,697	67,208	742
SELKIRK (Not divided)	8	255	3,956	..	156	2,050	1,269	7,375	1,815	12,549	560	3,305	183,497	771
SHETLAND — Mainland	..	635	5,251	..	1,734	867	997	566	1.265	7,685	1,838	9,810	117,886	227
SHETLAND — North Isles	..	16	1,213	..	438	126	315	139	494	2,781	922	2,978	32,143	175
STIRLING — Central	940	443	7.629	806	1,138	1,616	4,094	3,004	3,853	18,068	2,005	12,076	38,921	1,014
STIRLING — Eastern	1,122	525	6,215	549	792	1,234	4,006	3,045	1,634	15,635	1,345	8,896	5,479	1,129
STIRLING — Western	132	30	4,705	26	935	1,069	3,514	3,108	1,600	18,616	1,221	10,647	72,694	862
SUTHERLAND (Not divided)	..	445	7,824	..	1.103	2,834	4,476	5,544	1,512	6,774	2,197	10,527	207,146	843
WIGTOWN — Machars	41	308	11,462	52	341	4,736	4,364	20,737	4,021	29,076	2,738	26,505	66,044	4,928
WIGTOWN — Rhins	5	55	18,405	2	1,229	8,122	2,069	33,251	1,445	13,631	3,216	28,988	51,995	10,949

* To be harvested as corn.

† See Note on p. 5.

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STIMULUS FROM RURAL HOLLAND.[1]

J. W. ROBERTSON SCOTT.

Author of "A Free Farmer in a Free State (Holland)," "The Foundations of Japan: 6000 Miles in the Rural Districts," "Sugar Beet: Some Facts and Some Illusions," "The Land Problem," etc.

THE commercial, political and religious connection between Scotland and the Low Countries has been so close in past times—Scottish names are common in Holland; for example, our Lord Reay is Baron Mackay of Ophemert in the Netherlands—and there is so much similarity between the Scots dialect and Dutch that a Scotsman has a special interest in the agricultural and rural life that the Hollander has made for himself. Has made for himself, because, as everybody knows, there is substantial foundation for the saying of the Dutch people, "God made the sea, we made the land."

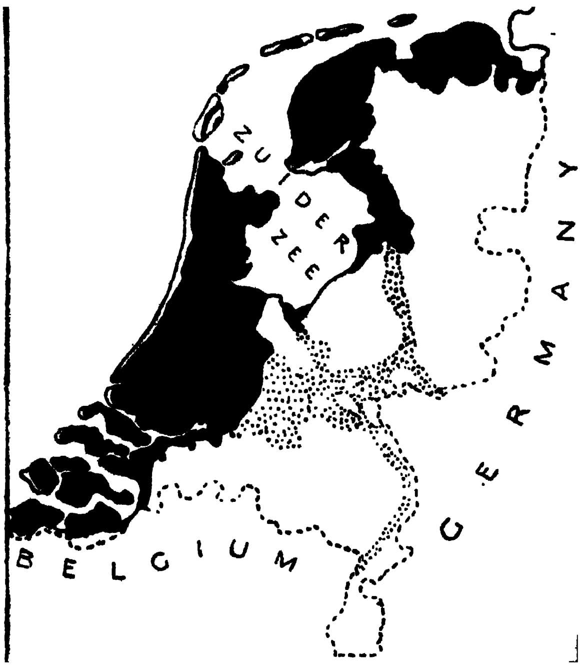
But they had to have something to make a beginning with. Some 99¾ per cent. of Holland is the product of sea and rivers and glaciers. To call Holland, as Motley did, the north-western corner of that vast plain which extends from the Urals, through Russia and Prussia, to the North Sea, is not to give so vivid an impression of it as Napoleon managed to convey when he declared, with characteristic unpoliteness, that Holland was merely the deposits of French rivers, the Meuse and the Rhine. Perhaps 60 per cent. of Holland is the work of rivers. What these rivers are equal to is realised when one comes across the statement that more solid matter is poured out of the country into the sea than enters it. What is poured out is not French at all. It comes from Switzerland.

Interesting, however, though sea and river-made Holland is to think about, it is not so interesting as man-made Holland. The first Hollanders kept their heads above water by making mounds for themselves and extending them by means of dikes. (The nearest word to "home" or "hame" in Dutch is *heem* which means both a farmyard and a dike). We may assume such mounds to have existed wherever there are villages with names ending in *terpen*, *werven* or *wierden*. There are villages on the top of *wierden* which are from 10 to 15 feet high and 15 acres in area.

[1] To the January number of the *Journal* Mr Robertson Scott contributed an article on "Stimulus from Rural Japan."

Think of the labour of the men (and women) who built the mounds, say, two thousand years ago!

To-day if we seek the key to the work of the man on the land we find it in the water level of the country. If the sea dikes broke, more than a third of the country would be overrun by an ordinary high tide. But in addition to the 1,500 miles of sea dikes there is an immense mileage of river dikes. If the river dikes



IF THE DIKES BROKE.

The black area would be flooded if the sea dikes broke and the dotted area if the river dikes broke. *The drawing is from "A Free Farmer in a Free State."*

went down as well as the sea dikes a still larger area of the country would be under water. If the initial cost of these sea and river dikes was huge, the cost of maintenance is tremendous. The dike of Norwegian granite at the Helder goes down 200 feet into the sea, and the width of the West Kapelle dike is a full 40 feet. There is a place where I found the depth of the sea at the dike 90 feet. If you look at the Ministry of Agriculture's figures showing how the land of Holland is divided up, you find that no fewer than 50,000 acres are dike! Within the lifetime of many readers of this article the coast of Holland has fallen two inches. The well-known seaside resort of Scheveningen has been moved back several times.

The extent to which the cultivable area of Holland has been increased by indiking and the pump is credible only to those who have chanced to compare maps of the Netherlands of a few

centuries ago with to-day's maps. When it was found possible to lift water by means of windmills, canals were made above the level of the land, and windmill-pumped water from low-lying areas was carried away in those channels. Whenever I see the phrase "the bosom of the deep," I think of the name given to a Dutch drainage canal (boezem). Sometimes the drainage canals (and the windmills) are in what may be called tiers, the water being forced from one to the other.

In the map of Holland in the atlas which my father used at school there is the Haarlem Lake, seventy square miles in extent. The great historian of Holland says that "exposed as it lay to all the winds of heaven" it was "lashed into storms as dangerous as those of the Atlantic." No one can have read unstirred his narrative of the water fights of the Liliputian fleets on this inland sea which attended the heroic defence of Haarlem. There are now prosperous farms and villages where there once was an inland sea, which in times of storms threatened the existence of Amsterdam and Leyden. Three hundred years old lake drainages were the Schermer (10,000 acres) and Beemster (17,000). The Schermer land is 13 feet below the level of the great Zuider Zee, with the drainage of a large part of which a beginning was made a few years ago. Possibly 76,000 acres of the Zuider Zee are available for poldering. Some notion of the area of this tract of water may be gathered from the fact that the excellent steamer which takes one across from North Holland to Friesland is an hour on its passage and that some 3000 vessels are employed in the Zuider Zee fisheries. For a salt water Zuider Zee there will be substituted one day a much smaller fresh water Zuider Zee.

No wonder that with all the canal digging that has been found necessary in Holland the length of navigable canals (1500 miles) is greater than that of the navigable rivers, and some of these have even been canalised, No wonder that the possession of a boat of 24 tons used to be a qualification for a vote in Holland. But the length of the navigable canals is a small matter compared with the length of the drainage canals of all widths and depths. It is the variation in the widths and depths of these drainage canals that makes the Dutch plan of military defence—a flooding of the surface too deep for wheeled traffic and too shallow for boats—so effective.

To tell the thrilling story of polder making—a polder is a reclaimed morass or lake—would require many pages. I noticed that in a single district of South Holland there are no fewer than 350 separate polders ranging in area from 12 acres to the 40,000 acres of the Haarlem Lake polder. Everyone of these polders is under sea level. Many are 16 feet below sea level.

It would be a long story, too, to tell either of the troubles of the *waterschappen* (water authorities) in keeping the water out of them when once made, or the story of the struggles between different *waterschappen* over the disposal and reception of water.

The complications of water management in the Netherlands are unending. They have had the excellent effect of educating generations of members of *waterschappen* in self-government. "They who suffer by the water," says the Dutch proverb, "must fight the water." The national struggle with the water gave country people the training which made them readily accept the principles of agricultural co-operation. Superior to all the great and little *waterschappen*, *heemraadschappen*, *hoogheemraadschappen*, *polderbesturen*, and *dijkbesturen*, whose official notices are in every inn and local paper, and whose powers in emergencies—think of what ice can do with the level of the water on an indiked river!—is the national waterstaat. Its yearly budget, even at pre-war money rates, was three millions. Its directory occupies three dozen pages in the Dutch Whitaker. It has been called *een staat in den staat* (a state within a state).

But in setting out some of the basic facts of the physical situation with which the man on the land in Holland has had to contend, the sand dunes must not be forgotten. They range from 200 yards to a mile and a quarter wide. The same kind of dunes can be seen (in the Culben Sands) on the Moray Firth and on the coasts of Cornwall, Cumberland and Norfolk, where in too many places the sand is allowed to blow over the good land. The author of "The Rise of the Dutch Republic" has pictured the dunes of Holland, "those wild and fantastic dunes, heaped up by wind and wave in mimicry of mountains; the long coils of the rope and sand by which, plaited into additional strength by the slenderness of bulrushes, the waves of the North Sea were made to obey the will of man." The Dutch have distinguished themselves by the planting of the dunes. They are not minded to have the dunes do for Holland what the Sahara has done for much of Northern Africa. Until one has visited the dunes it is not easy to realise what wind is capable of doing with fine sand. One approaches from farm land, where the cows tails are blowing about in a comical fashion, and finds oneself in sand where a hill may shift its position or a great hole be excavated in a few hours. With couch grass, leguminous crops and little firs, these shifting sands are being brought under control, and one day the children or children's children of the patriots, who have bent their energies to the work of afforestation in the unlikeliest conditions, will inherit a tumbled timber-clad country of no little beauty which may become a favourite site for country residences.

The sand of eastern and southern Holland is coarser stuff than the sea dune sand. This coarser sand and also sand removed in the preparation of dune land for bulb growing is taken all over Holland for engineering purposes and to make up levels on building land. It was with sand that some square miles of the site of the newer parts of Amsterdam have been raised 7 or 8 feet. It was sand on which the remarkable foundations of the Amsterdam Central Station were made. The place on which it was built was formerly part of the river Y. Some ten thousand

trains of forty or fifty waggons each brought the sand. Into the sand were driven piles (from Scandinavia) 75 feet long.

I have personal memory of the rate at which the dune sand has been removed near the great bulb centre at Haarlem. I once stayed at the village of Vogelenzang. Even from the somewhat raised railway tract it was impossible to see the church tower of the village of Hillegom. To-day the walk between the two places—it takes an hour—is as flat as a pancake and one takes one's way through a maze of canals.

Sand is also dealt with effectively in the famous Groningen fen colonies, the by-product of peat cutting. But not until all the peat is removed. You see in Groningen stacks of peats as big as churches. (Some of the strawboard and potato flour factories use peat only for their furnaces. There is a Dutch conundrum, "Which is the happy country in which the children burn their mother?") A thousand acres of what are called high fen are cut up into peat in a year. A canal has been dug out from Groningen into the peat country, and year by year this canal and its offshoots have lengthened until there must be more than fifty miles of the main canal and a hundred of the subsidary canals. It is a sight one can never forget, the stolid, mathematically straight main canal cut through the black peat barrier, and its offshoots leaving it at right angles.

At first, as in driving by the canal side, one gets clear of the town of Groningen, there is nothing, as far as the eye can reach, but cultivated land, such as one sees in the low fen areas of North and South Holland. There are small farms and neat villa-like, single-storey cottages, with roofs of shining tiles. (The main industry is the production of potatoes, which are so conveniently and cheaply carried off by the canals to the potato flour, yeast and spirit factories, or to the railways for exportation.) In Groningen province there must be 70,000 acres in which the high fen has been cut away and prosperous homesteads now stand. In the Netherlands, as a whole, there were even before the war a quarter of a million acres in which this transformation has been wrought.

So much for the areas in which the peat is no more. But, as one jogs along by the State canal, districts are reached in which peat may be discerned in the distance. The single storey cottages, farmhouses, look newer and newer. Very soon the black wall of still unhewn peat begins to close in, and the buildings by the canal side are brand new. Another mile or so, and bricklayers and carpenters are still at work, and there are no buildings at all. Finally, we reach water head, where the canal is being carried into the wilderness. There can be few more desolate sights in Western Europe than this wide expanse of shelterless high moor before the indomitable Hollanders fling themselves upon it and make cultivable land in its place.

There is no space for details of the way the high moor is fought. But the first thing to be done by means of the advancing

canal is to draw off the water. The fen loses about a third of its volume by draining. After the trenches that have been cut have brought away the water to the canal the top layer of high moor, which is moss litter, is cut away. Below that is peat, often to a man's height or more. It in turn is cut away. When that is done the sand beneath is exposed. On the sand the old top layer of moss litter is replaced. Above this moss layer about four inches of sand taken from the canal are laid. Then the surface is ploughed just deep enough to mix a little of the litter among the sand. The result is an easily worked peaty soil with plenty of water (in the sand) within reach for the crops to be. From time to time, of course, the plough is set a little deeper, and thus more and more peat is gradually united to the sand and to the humus produced by cultivation. I noticed that some farmers' horses wear wooden shoes, which serve like snow shoes to make easy movement possible over a springy surface. At length, however, the land gets sufficiently solidified for these foot guards to be dispensed with.

The work of turning the morass into agricultural land is done by "water companies," properly so-called, as the new waterways are the basis of the whole operation. The other product besides water is the peats, the removal of which before the war used to cost about £130 an acre. Levelling and sanding came to about six guineas an acre. Then there were the simple, economically built farmhouse buildings to be put up. The peats brought £200 to £260 per acre. The first two crops are potatoes. The fen colonies are said to spend more on artificials per acre than any other agricultural area in the world. But these artificials are bought co-operatively.

I have written at some length about this higher Holland, because it is the Holland that so few visitors see. Their time is spent almost wholly in the Holland below the level of the sea. Below the level of the sea! Any reader who has happened to be in a Dutch district in which a dike has broken in a storm has a vivid impression of what the phrase means. One year 9000 acres were spoilt by the sea. In another part of Zeeland I saw the work of a storm which had imposed a loss of £50,000. The sea had crumbled away sections of the dike, built with the experience and skill of so many centuries of dike building, and had strewn it contemptuously, as churned up mud, over miles of cultivated land. Battalions of diggers and carriers of earth, like ants, which on disaster threatening their homes, immediately set about the work of reparation, were to be seen indomitably repairing the wreck of parishes. The spectacle of what so lately had been well cared for fields, now slaked with sludge into a sodden waste, is not easily forgotten. Nor does the foreign observer find it difficult to understand how the desolation wrought by the inundations of the sea has ever stung the Dutch with a sense of insult which can only be wiped out by the subjugation of the waves once more. In one place I noticed that large vessels had been lifted by the storm

right over the remains of the dikes and dropped in what once were fields.

I have been speaking of damage wrought to dikes by the sea, but the piling up of ice in the rivers—to which allusion has already been made—and the melted ice water coming down on the top of it also make floods. Sometimes the ice blocks are broken up by dynamite. When danger is to be feared there are watchers on the dikes, where materials for use in forming coffer-dams are always stored. On the situation becoming serious, the inhabitants of the polders used to be warned by cannon, but no doubt the ubiquitous telephone is now largely employed.

When the stranger to Holland comes ashore from the steamer at Flushing or the Hook, or up the Maas at the Boompjes at Rotterdam, it is unlikely that it will occur to him that he is on a dike. When in the interior of the country, say as far away as the vicinity of the German frontier in Gelderland, he is riding along the public road, with the river in its summer bed half a mile or so off, it is also easy for him to forget, till someone gives the road its name of *dijk*, that he is journeying along the top of a barrier which in winter is the bank of a river.

The water level is, obviously, at the bottom of the distribution of Holland into grass and arable. Roughly speaking, you cannot cultivate land which is not a matter of, say, two feet out of the water, and there are large areas in Holland where it is impossible to get the water as low as that. Consequently there is pasture there. The part of Holland which the tourist sees when he goes from Flushing to Rotterdam, the Hague, Haarlem, Amsterdam and Utrecht, and makes a trip across the Zuider Zee—which will one day be the same kind of country—is the part where cattle are kept in the largest numbers, and butter and cheese are chiefly made. The best plough land is the sea clay, that is the alluvial marsh soil of Zeeland and Groningen; but the plough works in all formations in Holland where the water level is low enough—with several horses before it on the river clay, and with the minimum of power in sandy districts. As much as 46 per cent. of Holland is sand, with some gravel. Of the rest, 35 per cent. is sea and river clay, and nearly 19 per cent. is fen.

It is not only the polders and the dikes and the vessels' sails high above the level of the land that are a reminder of the artificial nature of a large part of Holland. One walks in the Vondelspark in Amsterdam and a motor drives past. The ground, because it is so very little higher than the water, shakes below one's feet. At Boskoop if one jumps on the ground by the side of the canal, the water eddies so much as to scare the pike. Aalsmeer, where there are so many nurserymen, consists, like the other Dutch Venice, Boskoop—where the well-known variety of black currant got its name—of extraordinary-looking little squares and oblongs of gardens, divided by strips of water. The gardens have been made either out of water or by laying canal load after canal load of earth on the top of the bog. The

front door of almost every grower's house and office at Aalsmeer and Boskoop is reached by a drawbridge. Canals, a yard or so deep when made, are dredged and re-dredged—the mud is wanted for the gardens—to the utmost depth at which their sides may be expected not to cave in.

The essence of successful culture of plants for transplanting is that they shall have bushy roots, such as are produced in the peaty soil of Boskoop and Aalsmeer. As shrubs, bushes and trees are sold out of the gardens the precious soil is reduced by the amount which clung to the roots of the plants that are gone. It is replaced by sods (brought from two hours' distance), and by canal mud. At one place I walked over 2½ acres of garden which had been made twelve years before by staking out the area in a mere, and then dumping into it innumerable boat-loads of sand, clay and soil.

The Dutchman has not only made for himself land out of water, sand and moor. He has given himself the advantages enjoyed by countries which lie within more favourable degrees of latitude. Between the Hook and the Hague there are 5000 acres of naturally wind-swept sand and clay called the Westland. But it is not now wind-swept. The 2500 market gardeners who crowd upon it have made themselves windbreaks; windbreaks of brick, windbreaks of straw and sacking, windbreaks of wood, windbreaks of cropped elm or willow. There are even screens to keep out the wind when the greenhouse doors are opened. Before the war there were five million square feet of glass in this naturally unpromising Westland—the winter cold freezes the ivy—where more than a thousand tons of grapes and strawberries are produced in the year. It is this very Westland which sends the loads of produce which compete so closely with British-grown stuff at Covent Garden.

How is it done? It is not done, it would appear, by advantages of soil and climate. It is not done by low rents. I found land in two places letting at from £50 to £60 an acre. I did not find rates and taxes lower than at home, for there is always the big water protection rate. Wages did not seem appreciably lower, and in this part of Holland there was no cheap women's labour. In another article I shall try to set out some reasons for the success which the man in the market gardens and fields of Holland has attained.

(To be continued).

THE DEVELOPMENT OF DAIRYING.

Impressions at the National Dairy Council in America.

J. C. Simpson, M.B., Ch.B., D.P.H.

It is necessary to realise that in dairying, as in all other commercial undertakings, there is a wide diversity of interests, frequently of a

conflicting nature. This suggestion cannot be levelled at the trade in America. Producers, distributors, scientific workers, manufacturers of machinery, government departments and consumers are all working in the common cause, not necessarily on the best lines, but, nevertheless, towards a common goal.

To suggest that all these interests are amicably, definitely and intelligently co-operating in this effort would appear to the unorganised Britisher to require a considerable amount of explanation. To get at the basal factor it is merely necessary to state that the great consuming public has been educated as to the quality of milk both from a butter fat and from a bacteriological point of view and, the law of supply and demand being inexorable, the answer is immediately suggested.

The consumer knows what he is entitled to get when he asks for milk, and insists on getting it. The question of the legal limit of 3 per cent. of butter fat does not arise—legislation and commissions are dispensed with; the consumer merely looks at the bottle in which the milk is retailed and notes the depth of cream thereon and immediately makes up his mind as to which distributor is providing the best value in terms of cream. In this connection it is interesting to note that the average cream percentage runs from 4 per cent. to 4·5 per cent. A retailer attempting to sell 3 per cent. milk would quickly close down. This immediately reacts on the producer, who of course gets a bigger price for the better quality, being paid on a butter fat basis. Under these circumstances, what are the inducements to add water? The distributor naturally places a higher value on milk which contains a higher proportion of butter fat, as his trade entirely depends on this factor. Milk and butter fat recording are therefore essential from the trader's and producer's point of view. It is interesting to observe here that, although there is a great diversity of opinion regarding the various breeds of dairy cow, it is frequently found that in herds not entirely Guernsey or Ayrshire a few animals of these breeds are kept in order to grade up the percentage of butter fat.

As regards the bacterial content of the milk, which, after all, is merely an index as to cleanliness of production, the public are equally educated. It is necessary to state here that a definite bacteriological standard has been insisted on by the local health authorities, varying, it is true, in various States, but nevertheless of very great value, and—this is the important point—the results of bacteriological investigations are published.

In this country little information would be available from a notice that a particular milk dealer's product contained 50,000 bacteria per cubic centimetre, but should such a notice be displayed, with varying figures, in every milk vendor's shop, curiosity would soon demand an explanation. A small amount of intelligence would suggest that milk containing 25,000 bacteria per cubic centimetre must of necessity be cleaner.

A point of controversy arises, however, in connection with this

subject. So much stress has been laid on the bacterial content that two very important and curiously dissimilar processes have been evolved in order to reduce it: (1) Cooling at the point of production; and (2) heating at the point of distribution. These have, as a common basis, the object of preventing the milk from souring quickly. Against the former no criticism can possibly be levelled. It merely retards the growth of the bacilli which give rise to the souring of milk and can in no measure affect the food value of the product. The latter procedure, which is described as pasteurisation, has as its object the destruction of these souring bacilli and any other disease-producing organisms which may have accidently contaminated the milk. This desirable result is unfortunately modified by the suggestion that the essential food factors in the form of vitamines are similarly destroyed.

This is rather a digression from the subject in hand, but so much importance has been attached to the subject of the bacteriological content of milk in America that practically every distributor of milk has in his employment a qualified bacteriologist. Thus the producer of milk, in order to obtain the best market, has to keep an eye on both the butter fat and bacteriological contents of his milk. In other words, he has to produce a rich and clean milk. This question of quality and cleanliness has loomed large in the dairying industry of America, and, as already suggested, their ends are attained entirely as a result of public demand.

The essential factors, then, which have given rise to a high-grade uniform product are simple legislation, including compulsory delivery in glass bottles, publication of bacterial counts and public demand.

This desirable state of affairs contrasts greatly with that in Britain, where in the majority of instances the public are in the unfortunate position of having to buy what may be metaphorically described as a pig in a poke, trusting to a casual poke being emptied by a Public Health official to find out whether the pig is a piner or not. It matters not that it may be enveloped in filth.

In connection with the production of milk in this desirable fashion in America, a very considerable amount of ingenuity has been displayed by the manufacturer of dairy machinery. Take, for example, an average distributor's premises in any town in the United States where pasteurised milk is sold, and the following procedure will give an idea as to the extent of machinery employed from the moment a railway truck, containing drums of milk surrounded by blocks of ice, draws up at the factory siding.

The uniform container is weighed, a sample is taken with a dipper and placed in a small numbered bottle for further analysis, the milk is smelt as a test for freshness and tipped into a receiver. From there it gravitates to a tank, where it is pre-heated with the exhaust from the pasteurising vat. It then gravitates into a clarifier, which is merely a centrifuge which gets rid of the grosser particles of dirt, hairs, etc. From here it gravitates to the pasteuriser, where it is held at a temperature of 145° F. for thirty

minutes, and thence it again gravitates over the brine coolers, where it is quickly lowered to a temperature somewhat below 50° F. From that point it passes to a machine where it is bottled, capped and sealed—the clean empty bottles being fed continuously by an endless track from an automatic bottle-washing machine, and similarly led away when filled to a platform, where they are placed in cases and then sent on their way by another automatic track to an awaiting delivery van.

The question of the education of the public has already been referred to as a factor in the production of better and cleaner milk.

It has been brought about largely through the efforts of the National Dairy Council. This Council operates as a national health agency with branches in all parts of the United States and is represented by paid officials. It is supported by the Government of the country, but it is not a Government department. It derives its income from all branches of the dairy industry, but the major portion comes from the producer and the distributor, each of whom pays approximately one penny for every ten gallons of milk produced and distributed. Needless to say, a large part of the activity of their officials is concerned with propaganda in order to increase the amount of milk consumed by the public. This is attained in various ways—by means of health lectures, which point out the value of milk and milk products as an article of dietary, by the publication of magazine articles, demonstrations to school children, etc. But, in a highly admirable and wide-spirited sense, they at the same time point out in a simple way what constitutes quality and cleanliness in milk in terms of butter fat and bacteriological content.

This, of course, necessarily reacts on the producers themselves, and forces them to produce and distribute an article which, in consequence, is demanded by the public. For this purpose they have a quality control department, which is engaged in educational work to improve the quality of the dairy product. This work includes the inspection of milk at collecting plants for sediment, bacteria and acidity; farm inspection; milk plant inspection; personal visits to dairymen for advisory purposes; educational meetings with lectures and motion pictures; actual demonstrations of clean, safe milk production; and appropriate literature.

It is difficult to give sufficient prominence to the extreme efficiency of this Council, both as regards its immediate and more remote effects. It may be referred to as a very decisive factor in the production of good clean milk and in increased consumption, leading to improved health and nutrition. In addition, there is another national asset gained thereby. An enormous tract of land, more especially in the Eastern States, which had become derelict and unproductive from a crop-raising point of view, is now becoming repopulated with cows and thereby regenerated. The American has realised that he cannot compete against virgin soil and cheap labour in the grain raising trade, and therefore he is concentrating

on live stock and their products with the advantage already pointed out. The potential increase in cows is enormous.

A glance at American statistics shows that American imports and exports of dairy products practically balance each other, and it is therefore evident that if the present dairying boom is carried further, as it assuredly will be, then there is distinct promise that before very long a considerable export trade is bound to arise.

Dried milk is a form of produce, the perfection of which is a matter that is occupying largely the attention of American scientists at the present moment. Already milk in this form is being manufactured at a very cheap rate, which, when reconstituted, is said to be indistinguishable from the fresh product both in appearance and taste. It has good keeping qualities, and has the advantage of being bacteriologically pure. The only apparent argument that can be levelled against it is that the vitamin property is destroyed during the course of manufacture, but, after all, precisely the same objection can be used against pasteurised milk. Further, this dried milk can be easily handled and transported at a very cheap rate. This forces the reflection that America will one day become a serious competitor in the markets of this country to our own detriment and that of our colonies ; and that it might be well to encourage and foster the dairy industry in our own country.

The National Dairy Show held at Syracuse, more than any other feature of the Congress, suggested the impression that in the dairy industry of America there was a degree of keenness and enthusiasm which is difficult to describe adequately. In this connection it is remarkable to note that many of the cattle shown came all the way from California—a five days' journey by rail. In order of popularity the favourite breeds appeared to be Holstein, Ayrshire and Guernsey. and there were some very fine animals shown in all the sections. A fair number of these were imported, but those bred in the States seemed to have quite as much quality as the former and were relatively uniform in type. It would appear that, contrary to the general impression holding sway in this country, quite as good animals may be bred there as in this country. No doubt there will be a certain demand for breeding animals from this side for some time to come, as a large number are needed for grading-up purposes, but it appears likely that this trade will steadily diminish.

In connection with this show the progressive nature of the dairy machinery manufacture was very clearly in evidence, but the criticism seemed obvious that much ingenuity had been expended on devices to make carelessly produced milk appear clean. On the other hand, there was much to commend in the plant designed for the purposes of distribution—such as bottle-washing, bottling and capping machinery. Labour-saving devices in every branch of the industry could not have failed to produce in a visitor from this side a sense of wonderment.

The subject of tuberculosis is looming large in the eyes of the American dairy farmer. He realises that the tubercle-free cow is a better "doer," and that a better price can be obtained both for its produce and for itself. Moreover, the question of tubercle-free milk as a factor in the health of the nation is fully understood and appreciated by all interested in the trade, as well as by the general public. In spite of the almost universal pasteurisation of milk which obtains, it is fully realised that this treatment is not a complete safeguard. It is noticeable that, although there is not nearly so much obvious bovine infection in the human population of the States as there is in this country, still a considerable amount of trouble is traceable to this cause.

The control of tuberculosis in cattle began directly as a result of the belief that much human tuberculosis was of bovine origin. Many schemes had been devised independently by several States which had as their basis the testing of cattle, the destruction of reactors and indemnification of owners. The more conservative method followed in Denmark and originated by Bang has been carried out officially only in a limited degree, but it has been used by many individual owners with marked success. In 1917 a tuberculosis eradication division of the Department of Agriculture was set up with a view to the control and eradication of the disease. In conjunction with the various State authorities, they co-operate with cattle-breeders' associations and herd owners. They adopted what is known as the accredited herd plan. It consists in making free tuberculin tests; removing, usually by slaughter, all animals that react; cleaning and disinfecting the byres; permitting only tested cattle to be introduced into the herd; making subsequent tests until there are two or three semi-annual tests without a reaction in the herd when it is accredited. In other words, the herd is placed on a roll of honour, which is printed at regular intervals by the Department of Agriculture, and a certificate is given to the owner by the State and the Federal Government. This entitles the animals of that herd to be moved from one State to another without any period of quarantine, and permits the owner to sell his milk at an enhanced price. Incidentally, it should be mentioned that the Federal Government allows an indemnity of about £12 per reacting cow, in addition to a varying amount paid by the State, when the total is not in excess of the appraised value of the animal. In March 1923 there were 25,135 herds accredited, and 271,023 herds that had passed one negative test.

Although the scheme is at present voluntary, practically all herdsmen are taking advantage of it, and the trend of public opinion is such that consumers of milk and dairy products are insisting on obtaining them from healthy cows. Boards of Health are passing regulations requiring that all raw milk sold within the area of their jurisdiction should come from tuberculosis-free cows. It is also likely that in the near future non-tested herds may be quarantined so far as the sales of animals or their products are concerned.

The amount of technical and scientific knowledge possessed by

the dairy farmer of the United States is as praiseworthy as it is surprising. Indeed, everyone with whom one came in contact—tradesmen and laymen—seemed to be possessed of an intense desire to improve and foster the dairy trade of America as far as possible. The National Dairy Council has already been referred to as an agent in the dissemination of knowledge, but the Department of Agriculture, as well as all State divisions, technical colleges, etc., have a very complete system of bulletin publications which reach all classes of the farming community. Research workers in the United States do not consider it a mistake to frame their bulletins so as to make them intelligible to the general public.

In regard to other methods of education it is only necessary to state that dairying is a compulsory subject in many of the country secondary schools to realise how much importance is attached to the subject from a national point of view. During the winter months short courses of instruction are given in many universities and colleges.

The final impressions created as a result of a visit to the National Dairy Congress in America only served to accentuate a pre-existing feeling that the dairy industry in this country is capable of being increased to a very marked extent, and placed on a much better footing from the point of view of quality and cleanliness.

VARIOUS TYPES OF SILOS.

A. W. OLDERSHAW, M.B.E., B.Sc. (EDIN.), N.D.A.

DURING the past few years there has been a great revival of interest in silage in the British Isles. Much interest was taken in the subject about forty years ago, and a large number of silos were constructed at that time. A few farmers have continued the system regularly since, but in many cases it was given up. The introduction of the cylindrical silo has, however, led to an enormous development of silage farming in America, and there is an increasing interest taken in the subject in this country. This is probably due partly to the introduction of the cylindrical silo and partly to an increasing appreciation of the fact that certain arable crops are far more productive than grass, and make equally good silage. Some of these crops are very difficult to make into hay, especially in a damp district and under northern conditions, hence silage is really the only way of satisfactorily preserving the crops without serious loss in an average season.

In view of these facts it was considered that a short description of some of the various types of silos in use in this country would be of interest.

Cylindrical Concrete (Reinforced).—There are a large number of silos of this type in various parts of Great Britain and Ireland. Most of them are monolithic, *i.e.*, walls of solid concrete erected *in situ*, whilst others are of concrete blocks. Amongst the first silos

of reinforced concrete to be erected in this country were those built by Mr F. W. D. Robinson of Roos Hall, Beccles, Suffolk, and by Mr James Cruickshank, Cruden Bay, Aberdeen. Mr Robinson's first silo was erected on the general lines advocated by Mr Digby Hussey De Burgh of Drumkeen, Pallas Green, County Limerick, in his book entitled *Ensilage.*[1] It was filled for the first time in 1915, having been erected a few months previously. Quite a number of concrete silos were built in the neighbourhood of Beccles very soon after Mr Robinson had been successful in feeding silage. Most of these silos were built with the farmer's own labour, the walls being 1 foot thick.

The most common size is 30 to 35 feet internal height, and an internal diameter of 15 feet. Five door openings appear to be sufficient for a silo of 35 feet high, with a wooden door to fit in a ledge, this door being kept in place by the pressure of the silage. In the spaces between the doors short iron ladders may be fixed in the concrete at the time of erection. Over each door space is then placed a hanging iron ladder, attached to the lowest rung of the ladder immediately above it. An alternative method is to have a wooden ladder attached to bolts embedded in the concrete, with moveable rungs over the doors. A wooden chute is usually fixed over the doorways and ladder—this serves to conduct the silage down without waste, when it is taken out during the winter. The above arrangement with a small number of doors seems much better than the continuous door which is sometimes provided and which must lead to a weakening of the structure, and also involve more expense. Several of the pioneers of silo building above referred to used a wooden mould made by a local carpenter which cost £7, 10s.

Old iron was used for reinforcement—steam plow cables, barbed wire, and in one case old bedsteads. A concrete silo, erected by Mr Sam Balls of Carlton Colville Hall, Lowestoft, was described by the writer in the *Transactions of the Highland and Agricultural Society of Scotland, 1917* ("Modern Ensilage Practice"), and it is not necessary to repeat the description.

It may be mentioned, however, that this silo has an internal diameter of 15 feet, and an internal height of 30 feet (5 feet below ground). The walls are 1 foot thick. The materials used included 45 tons of gravel, 10 loads of sharp sand and 12 tons of cement. This building was erected in 1915, and cost £112.

Mr Balls, writing in December 1923, states that this silo has never cost him a penny for repairs, and that it is as good in every way as it was on the day it was completed. Although it has been filled eight years in succession, the inside is as smooth as when it was just built, and there is not a flake of cement off anywhere. Mr John Oldrin, of Rushmere, Lowestoft, erected a cylindrical concrete silo in the summer of 1915. This silo has an internal height of 25 feet, aod an internal diameter of 15 feet, the walls being 1 foot thick. Mr Oldrin has applied a coat of tar thinned

[1] Published by Mausell & Company, Dublin.

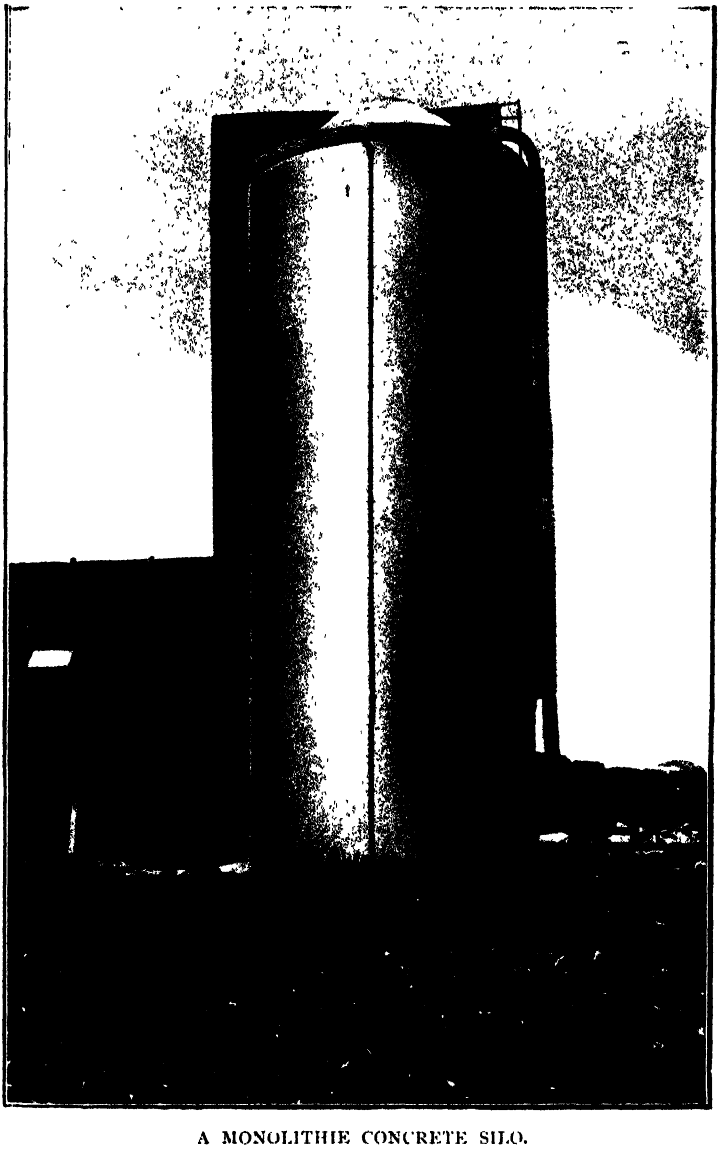
with paraffin to the internal walls; this gives a very smooth wall, and results in a minimum of waste on the sides. This silo when examined by the writer in February 1924, showed no signs of deterioration, the silage in the lower part of it had been in the silo since the summer of 1922, and was of extremely high quality. There was scarcely any wastage, and a portion taken from the outside within an inch of the wall appeared to be of as good quality as that taken from the centre of the silo.

Of the many concrete silos known to the writer only one has developed a crack, and that is not a serious one. The statement has sometimes been made that the acid of the silage affects the concrete walls, but an inquiry amongst owners of several concrete silos has not brought any such case to light.

The erection of concrete silos has recently been taken up by firms of builders and concrete specialists. Where this is the case the reinforcement is usually of iron or steel rods, and the walls are usually thinner—sometimes 6 inches thick and sometimes only 2 inches thick. In this latter case the cement is merely plastered upon expanded metal without the use of a mould. The chute and roof also may be made of concrete.

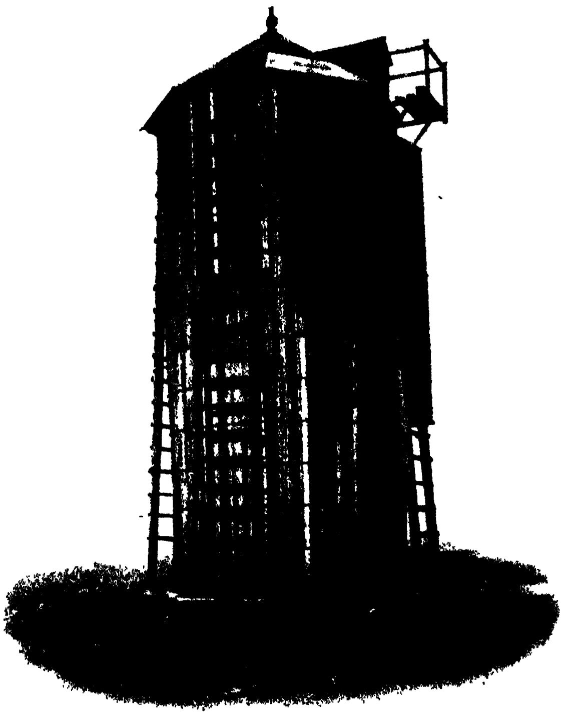
The cost of concrete silos naturally varies very much according to the ease with which sand, gravel, etc., can be obtained locally, and also with the local price of Portland cement. The cost may also be very much reduced when the carting and some of the labour can be done by the farmer's own men. Estimates by various contractors made in December 1923 for a concrete silo 16 feet in diameter and 32 feet high varied from about £320 to £245. Where the farmer has a taste for supervising that sort of work himself, as in the cases referred to in Suffolk, it is probable that these figures could be considerably reduced.

Concrete Block Silo.—The writer is indebted to Mr A. J. Jeffers, Drumleck, Castlebellingham, for the following description of a concrete block silo erected by him during the summer of 1922. The silo was erected, under Mr Jeffers' supervision, by a handy man, assisted by the farm men. It is 40 feet high, is cylindrical, and has a diameter of 16 feet, the walls being 4¼ inches thick. The blocks, which are 15 inches by 9 inches by 4 inches, were fastened together by concrete mortar. The structure is reinforced by round iron bars, 12 feet by ⅜ inch, laid horizontally round in a groove on the top of each layer of concrete blocks. The blocks were made with a 1½ inch groove in the ends to key them together with mortar, and to allow the iron rods to be turned down at the ends; there was also a groove in the top of each block to take the iron rod. There are four doors in the wall of the silo, covered by the chute, and one in the roof, the size of the doors being 23 inches by 44 inches. The foundations of the silo are 2 feet 6 inches deep and 1 foot 6 inches wide, and the blocks were built on these. The roof is of wood, covered with rubberoid. The chute is of larch boards, 5 inches by ⅝ inch, bolted to irons let into the concrete

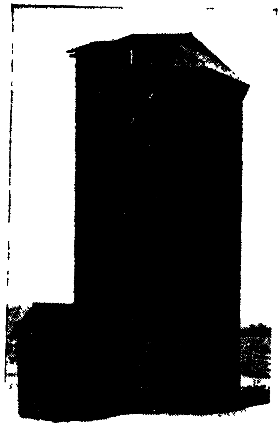


A MONOLITHIE CONCRETE SILO.

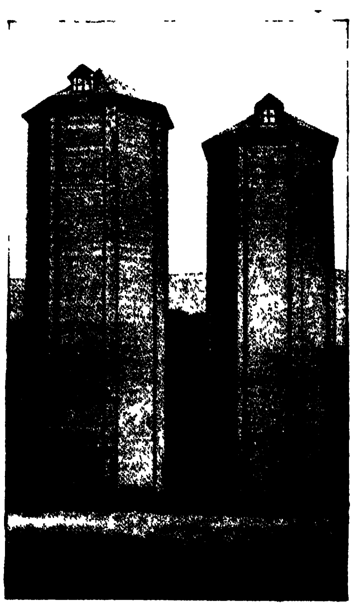
A HOME-MADE MONOLITHIE SILO BUILT WITH THE FARMERS OWN LABOUR, WITHOUT THE AID OF A CONTRACTOR.



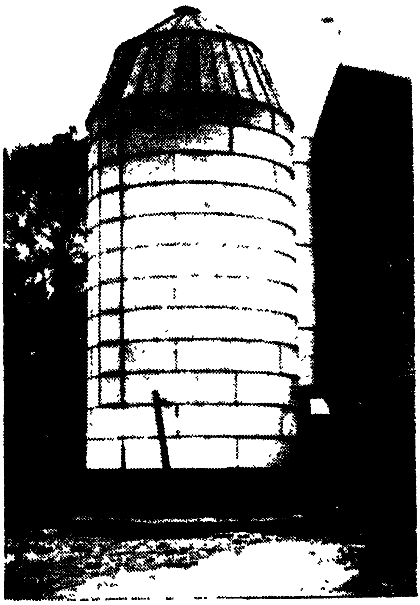
A WOODEN STAVE SILO.



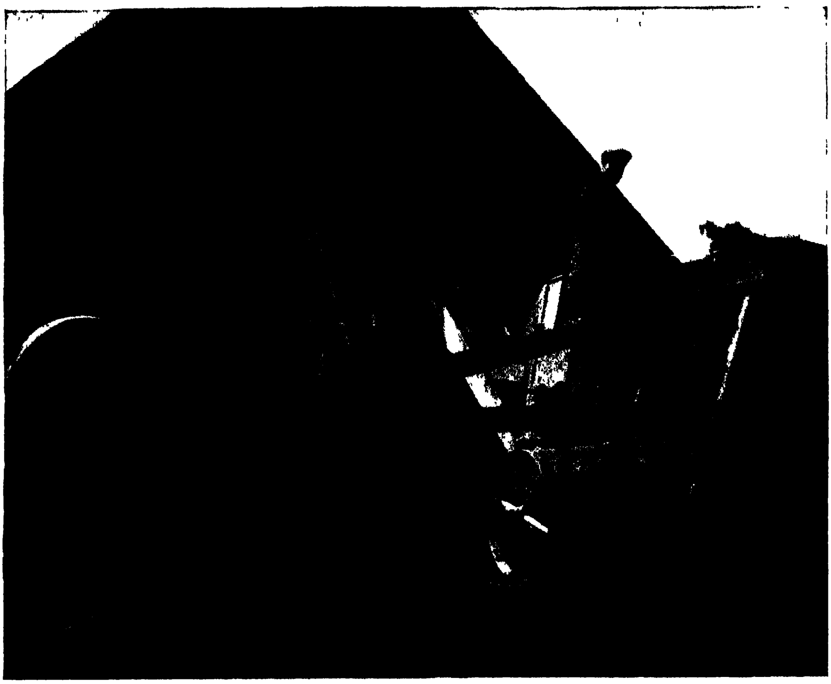
ANOTHER TYPE OF WOODEN STAVE SILO.



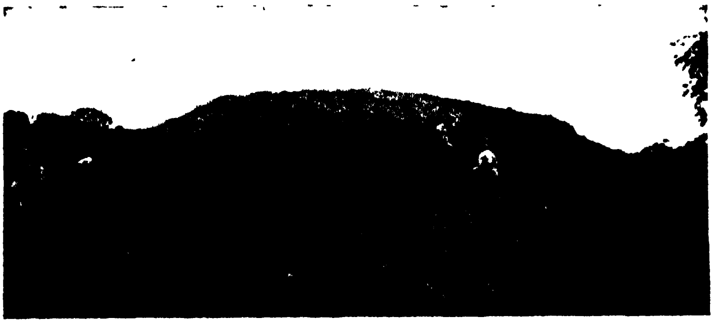
A PATENT WOODEN SILO.



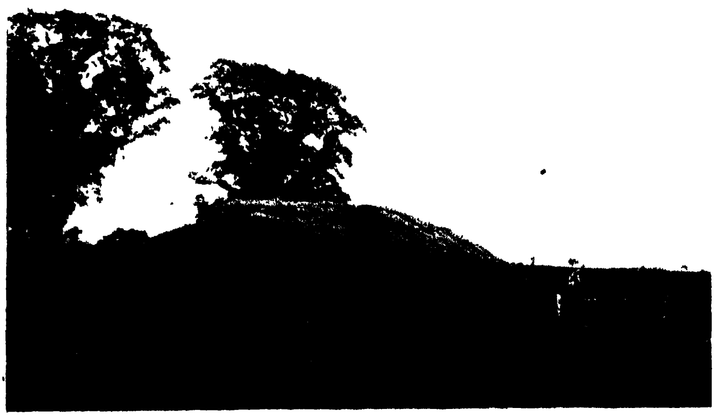
A STEEL SILO.



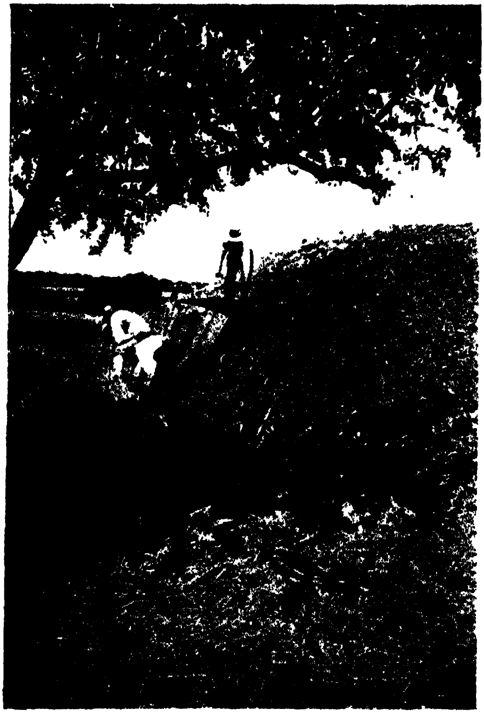
AN IMPROVISED SILO IN A BARN, BEING FILLED WITH A HOME-MADE ELEVATOR, WITH ENDLESS CHAIN AND SLATS.



A TRENCH SILO FILLED AND IN COURSE OF BEING ROOFED WITH EARTH. A SMALL PORTION IS SEEN UNFINISHED



BACK VIEW OF THE SAME TRENCH SILO.



SHOWING STAGING USED WHEN EARTHING OVER TRENCH SILO.

at the side of the doors at the time of building. The silo was plastered inside, and given a fine finish with cement.

When the silo was 24 feet high the crop was ready to go in, so the scaffolding was removed and the silo filled with green stuff. This was covered with peat moss litter, and the building of the silo proceeded with.

In building the silo 7 tons of cement, 60 loads of sharp sand and 12 tons of stone were used, and the total outlay, exclusive of the cost of carting, was less than £150. Nothing is included in the figure for supervision, which was done by Mr Jeffers. Up to the present no signs of cracking whatever have been seen in the silo. Mr Jeffers selected the concrete block type of silo because he formed the opinion that it would be cheaper than a monolithic silo.

Brick Silos.—There are several brick silos in Hertfordshire and Essex. In one case a silo was built of 14 inch brick walls reinforced with hoop iron; it is 28 feet high and 20 feet in diameter. The roof is covered with weather boarding, and there is a Boyle's ventilator on the top. The inside of this silo has a coating of cement containing a proportion of "Pudlo," and is polished perfectly smooth with a steel trowel. In some cases these silos are built so that the material can be placed in them in an unchaffed condition. In this case an ordinary farm elevator is used, and the material is put in through double doors, which are 5 feet 6 inches long. Smaller doors, about 2 feet square, are also provided for putting the material out.

Mr T. D. Heaver of Ratham, Chichester, stated recently that he is quite satisfied with his brick silos—they have not cracked, and he has not spent a penny on them for upkeep. On the other hand, a brick silo erected by a well-known Essex farmer some years ago cracked badly. It was repaired, but the repairs did not prove satisfactory, and considerable trouble and loss was the result. This farmer now writes that he would not have a brick silo as a gift.

Metal Silos.—These are constructed of standardised sheets, flanged on each end and double flanged on the bottom, this double or apron flange acting as a reinforcing rib round the silo.

Each metal sheet is fastened to its neighbour by means of bolts, and in the joints between each sheet a special material is inserted to prevent air gaining admission. The foundations of the silo consist of concrete, into which special anchor rods are set. The erection of this type of silo is simple, and has been performed without the aid of specially skilled men.

As the silo is in sections, it is possible to increase its height at any time desired. A metal roof is also provided. In order to guard against rust, it is necessary to paint the silo from time to time.

The silos of this type known to the writer have been recently inspected, and appear to be quite satisfactory. They have only been erected a short time, but no very obvious signs of rust or

other depreciation are as yet visible. During the winter 1923-24 the cost of a silo of this type, 14 feet 4 inches in diameter and 32 feet high, was about £245, inclusive of the foundations and cost of erection.

Wooden Stave Silos.—There are a number of silos of this type in various parts of the British Isles. A wooden stave silo resembles a huge barrel except that the sides are perpendicular instead of bulging. Iron bands pass round the whole structure and hold the staves together. These bands can be tightened when required. A series of doors, one above the other, is arranged on one side of the silo, and it is usual to have a chute covering these. The workmen, when removing the silage, climb up inside the chute, which also serves to conduct the silage down to the ground or to the mixing shed.

In the case of the first silos of this type erected in this country guy ropes were necessary to act as anchors to the silo, but in certain newer types of wooden silos these are no longer necessary. Quite a number of wooden stave silos which were built ten or more years ago are still in existence. Where they have been carefully attended to, they are still in good condition. Some owners, however, state that the expense of upkeep has been by no means negligible. If wooden silos are neglected and holes are allowed to form in the sides, air gains admission and considerable waste of silage results.

The question of the durability of wooden silos in this country is a very important one, and owing to the comparatively short time during which they have been in use, it cannot yet be regarded as definitely settled. *Bulletin No. 200 of the Colorado Agricultural College* states that "the life of the stave silo varies from five to twenty years according to the quality of the material used, the method of contruction and the care and attention given to the silo."

The cost of a stave silo 16 feet by 32 feet made of creosoted wood was, during the winter 1923-24, about £250 to £270, exclusive of the cost of cement concrete foundation.

Patent Wooden Silo.—This silo has not been on the market in Great Britain for very long, but quite a number have been erected in Northern Ireland and a limited number in Scotland and England. They are built like a child's box of bricks, the sections coming ready cut and fitting into each other. The silo is octagonal in shape. This, however, is not a serious disadvantage, as, if the material is well trampled down inside the silo, as it ought to be in every type of tower silo, there should be very little loss from that cause.

Those who have erected silos of this type speak favourably of them—they are very easy of erection and in some cases have been put together by boys, under supervision. It also appears that they do not increase and decrease in diameter according to climatic conditions. In one case which came to the notice of the writer there was some waste in three out of eight corners—those on the south side—which was attributed to the drying action of the sun.

Silos of this kind have been on the market for such a short time in this country that no information exists as to their durability. It appears probable, however, that they are similar in this respect to other wooden silos. There are quite a number of sizes of this type of silo supplied.

A silo 16 feet diameter and 30 feet high estimated to hold 119 tons of silage cost £131, 10s. in December 1923, exclusive of the cost of roof and chute, erection and foundations.

General Observations on Tower Silos.—Those who propose to erect a tower silo of any type will do well to give careful consideration to its site. If it can be erected in such a situation that the chute actually opens into the mixing-house of the byre, or very near to it, a great deal of labour will be saved in carting the silage. In some cases, where the silo cannot be arranged against the byre, it may be possible to arrange a short covered passage from the chute to the mixing-house.

Very good silage can be made in almost any type of tower silo, provided air does not gain admission either at the doors or the walls. Defects of any kind in the walls or doors are apt to admit air and so cause loss. The material of which the silo is constructed must also be such that no appreciable amount of drying of the outside layers of the silage can take place. It is essential that the walls of the silo shall be smooth, so as to allow the silage to sink without leaving air pockets. When filling the silo, the green material should be well trampled, especially round the outside and near the top of the silo. Very often there is a considerable amount of waste on the top of a tower silo—this can be largely prevented by placing a small thickness of long grass on the top and then covering up with sand to a depth of 6 inches. The operation of hauling up four loads of moist sand for this purpose and covering in one case took only two hours. When this precaution is adopted the waste is reduced to a minimum. The plans sometimes advocated, of sowing oats on the top or adding salt, do not appear to be satisfactory. Ordinary chaffed straw has sometimes been used for covering up, but it is not so good as sand.

Most types of tower silos require the green material to be first chaffed and then elevated. This is usually done by a combined cutter and blower, which costs nearly a hundred pounds at the present time. Several cases are known to the writer in which blowers or other elevators have been attached to the ordinary farm chaff cutter. In one case cup elevators attached to an endless chain, elevate the material, whilst in another a slat elevator, also attached to an endless chain, does the work.

The type of cutter which gives a clear cut, like an ordinary chaff cutter, appears to suit the crops commonly grown for silage in this country better than cutters in which the knives are of the lawn mower type. The latter, especially when cutting rather strawy material like rye or oats, occasionally leave pieces several inches long. The lawn mower type of knife is probably better suited for maize than for the crops commonly grown for silage in this country.

It is a great mistake to erect a silo with too large a diameter. The silage is better and sweeter when a comparatively small area is exposed to the air. In one case a concrete silo was erected with a diameter of 25 feet, and although the owner had a very large herd of cattle he found it impossible to use the surface of the silage quickly enough. He has now put a wall down the middle of the silo and divided it in two. A fork may be used to dig out the silage, but this is apt to result in a deep hole being made which admits the air and causes deterioration of the silage. A strong hand rake with good tynes to rake off the surface is sometimes used with good results. If a fork is used it should have short tynes.

Silos made from Disused Buildings.—Quite a number of cases are known to the writer in which disused buildings have been modified and are now being used as improvised silos. Usually one end of a barn or similar building has been lined with cement, the corners rounded off, and a concrete wall erected to divide it from the main portion of the building. It is also desirable to reinforce the walls with concrete props. Suitable doors for the removal of the silage can be made in the concrete wall, whilst a small door for admitting the chaffed green material is made near the roof at the end of the building. Old cattle sheds or barns have been utilised in this way and excellent silage has been made. As, however, it is not usually possible to secure so much pressure on the top owing to the fact that the height is less than with a tower silo, it will usually be found necessary to weight the silage on the top with sand.

The area of surface in a silo of this kind is usually rather large, hence it is better to remove the silage with a hand rake, rather than with a fork, as less air is admitted in this way.

True Pit Silos.—Only one silo of this kind is known to the writer in this country, but there are a large number in America. The true pit silo is a cylindrical hole in the ground—usually lined with cement, and with a concrete curb round the top. The silo referred to above is on a farm near Southwold occupied by Mr H. C. Boggis of Park Farm, Wrentham, Suffolk. It is a cylindrical hole 12 feet deep by 18 feet in diameter. Sheets of corrugated iron are fixed round the edge for a height of 6 feet, and in this way a total depth of 18 feet is obtained. The pit is not cemented in any way, but is filled with chaffed material and good silage results, although there is a certain amount of waste on the sides. This would not be the case if the sides were cemented.

These underground silos can only be made where there is a considerable depth of firm but light soil, free from rocks, and where the water table is always below the bottom of the floor. The soil is removed from the pit by means of a hoist, which is also used to remove the silage subsequently.

In view of the very limited amount of experience of pit silos available in this country, persons who contemplate making one would do well to peruse *Bulletin No. 825 of the United States Department of Agriculture* entitled "*Pit Silos.*"

Disused Gravel Pits or Similar Holes used as Silos.—Pits of this kind were used by makers of silage in East Anglia, before they had more satisfactory silos available. The opening to the gravel pit was roughly supported with wood, a chaff cutter was fixed on the side of the pit, and the pit then filled—in the cases under observation to a depth of 15 feet—with chaffed green material.

The green stuff was then covered with rough waste material—nettles, etc., then with soil and finally weighted down with logs of wood, stones, etc. Quite good silage can be made in this way, but the air is apt to gain access at the entrance to the pit and if this happens, waste is inevitable.

Earth Covered Silage Heaps.—Meadow grass can be made into quite good silage by making it into a heap, resembling a manure heap, carting over it and then covering with earth. The resulting silage has a tobacco-like smell. The objection to this method is that there is apt to be too much waste.

Stack Silage.—Meadow grass has been made into good silage under the observation of the writer, in cylindrical stacks—usually with a base diameter of 18 to 24 feet.

The stack is taken upwards as high as possible, say 15 feet, the outsides especially being well trampled during the process, the middle is then well roofed up, being if possible 4 feet higher in the centre than on the outside; the sides are trimmed with a hay knife, a layer of hedgeside waste material is placed on the top and the whole roof covered with earth to a depth of 9 inches or a foot.

This method of making silage is probably best suited for green grass as this goes together very closely; it is, however, used for other green materials. Sometimes wire ropes are passed over the stack and pressure brought to bear upon the contents by means of a ratchet arrangement. The success of stack silage depends largely upon the extent to which the material, especially that near the sides, can be consolidated so that air does not gain access. A pony walking about on the stack during erection is a help in consolidating the mass. If the operation of erecting the stack can be proceeded with at intervals of several days, time is allowed for settling and the resulting stack can be made to hold more green material.

Trench Silos.—Of all methods of making silage without the use of a tower silo, which the writer has had an opportunity of studying, this seems to be the most promising. A large number of farmers have adopted the system and if a few simple precautions are taken there need be very little waste. The silage is really made into an oblong stack, partly beneath the surface of the ground, so that, instead of the sides being exposed to the air as in stack silos, they are surrounded by moist earth, which keeps out nearly all air. I have used the term "trench" to distinguish this type of silo from the true "deep pit" silos previously mentioned. This method of making silage has been in use for many years and its present success is due largely to the skill of Mr Wm. Makens

of Colney, Norwich. Mr Makens has several trenches which have been regularly in use for more than thirty years, the largest being 25 yards long, 4 feet deep and 15 feet wide. The length must be varied according to the quantity of green stuff to be put in, but it is usually convenient to have the trench about 13 to 15 feet wide (this gives room for the carts to go over the heap of green stuff lengthways) and from 2 feet 6 inches to 4 feet deep. Where the soil is light, it is better to have the trench fairly deep. Where the soil is heavy or in a district of heavy rainfall, one end of the trench should be slightly lower than the other, and a drain should be made from this end to take away the water which is apt to collect after some of the silage has been removed. For this reason trench silos are often made near a ditch. In some cases the trench is made with a sloping end, so that the carts can back in when removing the silage.

The contents of a trench silo will naturally depend to a great extent upon the height which it is carried above ground. As a rough rule it may be estimated that with a trench 14 feet wide and 4 feet deep about 1 yard to 1¼ yards of length will be wanted for every acre of oats and tares (12 tons of green stuff per acre average crop) to be ensiled.

When filling the silo, the green material is simply tipped in until the horses and carts can enter, when it is carefully trampled. It is then made exactly as is a "draw over" dung hill and the process continues not only until the pit is filled, but until the mass of green material has reached a height of several feet above the ground, when the sides and ends are pared where necessary, and the whole is topped up with hedge side waste materials. As soon as the crop is in, the whole should at once be covered up with earth to a depth of 6 inches to 8 inches. After the heap has settled, the roof which was originally made very steep and well rounded, should receive a little attention, in order to see that any cracks in the soil are filled in. Sometimes, if the roof has not been made steep enough, hollows are apt to form in it, which let in the water and cause the silage to rot. In a wet district it would probably be an advantage to thatch the roof roughly after settling, as this would reduce waste on the top. If the material is allowed to get old and rather dry before ensiling waste may occur owing to mould. On the other hand if the crop is very green and watery when cut, it is probably best to allow it to remain in the field for a day, after cutting, in order to lose moisture. If care is taken to exclude air as far as possible, to consolidate the material and to prevent any considerable quantity of water gaining access to the roof or, owing to lack of drainage, to the silage below ground, very good silage can be made in this way, with very little waste and at very little expense.

In making silage either with towers or in trenches, there is apt to be waste unless reasonable precautions are taken. In this respect, however, the making of silage in no way differs from other common farm operations such as hay making or the harvesting of

corn—neglect of certain simple and well-known precautions leads to waste and loss of crop.

Prospects of Ensilage in the British Isles.—The silage system appears to be making rapid headway in this country, as it has done in America. Amongst the scores of farmers known to the writer, who have adopted it, not one has ever expressed in his hearing any disappointment with the results obtained; on the contrary most of them are loud in its praises. It is founded upon the sound principle that green crops grown on arable land produce two or three times as much food per acre as does grass land. It also enables us to utilise to a much fuller extent the invaluable power of leguminous crops of obtaining nitrogen from the air. Furthermore, it acts as a sort of safety valve to the farmer—he can grow both roots and silage for his stock, and it is a very unusual season indeed which proves bad for both of these crops. The fact that well-made silage will keep for more than one year also adds greatly to its value and tends to minimise losses owing to unfavourable seasons. The silage-making farmer need not fear a wet hay harvest—even crops so succulent as peas, beans and tares can be preserved without fear of much loss in the wettest parts of the British Isles.

THE BIOLOGIST ON THE FARM.—No. XIII.

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Do Identical Twins Occur in Cattle?—Identical twins, which are always of the same sex, are believed to arise from one ovum. Ordinary twins, which may be of the same sex or of different sexes, arise from two ova. The question whether identical twins occur in cattle is of some interest in connection with the interpretation of the abnormal kind of offspring known as a free-martin. It has been recently discussed by John W. Gowen (*Biological Bulletin, xli., No. 1, pp. 1-6*). There are three lines of inquiry. The surest is to obtain knowledge of the condition of the ovaries in a cow that has produced twins. Then there is a statistical inquiry into the normal sex ratios occurring in multiple births of cattle in comparison with those occurring in species, like the human species, where identical twins do occur. The third approach consists in a comparison of the colour markings in twins of the same or opposite sex. The conclusion reached is that identical twins, arising from one egg-cell, are rarely or never produced in cattle. If this conclusion is correct it is fatal to one of the theories of a free-martin, which regards the abnormality as an undifferentiated male formed from the division of a single male-producing egg-cell.

Twinning in Pigeons.—Everyone knows that pigeons lay two eggs at a time—"a doo's cleckin" After a short interval

the second egg follows the first from the single ovary. But twins within one egg-shell are *very* rare. In about 20,000 brooded eggs of doves and pigeons Professor Oscar Riddle obtained only eight twins. Five of them came from extremely large eggs and three from extraordinarily small eggs. The sex was determined in three of the five that came from very large eggs, and it was female. This corroborates the theory that large size of egg is correlated with femaleness, but the numbers in this case were unfortunately small. Riddle's view is that twinning in pigeons, which means independent development of the egg from two centres instead of from one, is associated with some change, either accelerative or retardative, in the normal rate of development during the early stages. Perhaps this rate of development is associated with the rate of the chemical routine or metabolism within the egg. Twinning within one shell is regarded as an approach to abnormality, and it has been shown that abnormalities are readily induced in early embryos by high concentrations of carbon dioxide—a sort of suffocation. Increased concentrations of oxygen, decreased oxygen, and low temperature produces less frequent abnormalities in the order named.

Crowing Hens and Hermaphrodite Fowls.—For some birds, such as ducks and hens, it has been proved that the female has many of the masculine characters, such as those of plumage, *up her sleeve*. They are kept latent by the chemical messengers or hormones, which are carried by the blood from the glandular tissue in the ovary. If the ovary should degenerate (or be removed) the embargo on the latent masculine characters ceases. Then the duck puts on the plumage of the drake; then the hens try to crow, and otherwise misbehave themselves. The latent masculinity asserts itself.

Very different from this is the occurrence of fowls which are male and female at once—true hermaphrodites. Thus a nine-year old Rhode Island Red Fowl, recently described by Hartman and Hamilton (*Journal of Experimental Zoology*, 1922, pp. 185–203, 2 pls.), had on the right side of its body a male organ or testis, and on the left side of its body a combination of an ovary and a testis, which may be called an ovotestis. These reproductive organs, on both sides of the body, were active; so it is not surprising that this remarkable fowl displayed the external characters and the behaviour of both sexes. It must have been in a bit of a quandary, and at its time of life too! But our present point is simply to distinguish from true hermaphroditism in poultry, which is not common, the not infrequent putting on of masculine plumage and other superficial characters. In short, the "crowing hen" is no hermaphrodite.

Another Crowing Hen.—A striking case has been described by Murisier (*Revue Suisse de Zoologie*, 1923, xxx., 275–284, fig. 1). It concerned a hen that was for a year a good layer and a good mother, Next year, however, she began to be queer; she acquired a cock's crow and a cock's behaviour. Then she died. The

autopsy showed an ovarian tumour (*fibrous sarcoma*). The formation of ova had quite stopped. There are at least two possible interpretations of what happened. As we have seen the female bird has certain masculine characters in a latent state. They are kept from finding expression by an internal secretion or hormone formed in the ovary and distributed through the body by the blood. When the ovary is removed from a duck she puts on the plumage of the drake. Now in the case of Murisier's hen it may be that the stoppage of ovarian function in consequence of the abnormal growth, acted like a removal of the ovary, and allowed certain latent masculine characters to find expression. But one must not too hurriedly exclude the possibility that the tumour operated more positively by liberating products into the circulation, which acted like a hormone from the testes in the case of a male. The hen in question showed no hint of testicular tissue in the diseased ovary.

Is Stoutness Hereditary?—We do not wish to rush into a discussion of the problems of animal nutrition, where we certainly fear to tread; but we may be allowed to call attention to a recent contribution by Dr C. B. Davenport on the hereditary factors in body build (*Proc. Society Exper. Biology and Medicine*, 1923, xx., pp. 388–390). Some authorities, like Van Noorden, would be inclined to say that there is no hereditary factor in such a character as obesity, that it is all a question of nutrition, what biologists call modificational. The Scotch are slender, the Eastern Jews are stout; but the difference is not germinal or constitutional—it is due to the handing on of certain traditions of feeding. But it is not easy to see how this would apply to the difference between Jersey steers and Aberdeen-Angus steers.

Others would say that, while feeding habits count for something, there is a constitutional difference in the degree of functioning of the endocrine glands. But without committing himself to any endocrine theory, Dr Davenport has got some evidence showing that there are definite hereditary factors determining body build, just as there are definite hereditary factors determining stature. There are, he says, in cattle and in men generally two or more genetic or hereditary factors involved in build. The factors for fleshy dominate slightly over those for slender build. In this sense stoutness is hereditary.

Pin-Worm of the Horse.—A fresh study has been made by Benjamin Schwartz of the common pin-worm or oxyure of the horse. Just as man is troubled by *Ascaris lumbricoides* and *Oxyuris vermicularis*, so the horse is troubled by *Ascaris megalocephala* and *Oxyuris equi* (also known as *O. curvula*). The recent study of *O. equi* was made in the Philippines, but the parasite is the same as that which affects horses in this country. The female is two or three inches long, like a piece of string, but tapering to a thread posteriorly. It occurs in two forms—a long-tailed (*mastigoides* type) and a short-tailed (*curvula* type). As is usual among these thread worms, the males are much smaller than the females.

The parasites occur in the cæcum, the colon and the rectum of the horse. The life-history appears to be simple and direct. From the horse the microscopic enshelled eggs pass on to the ground and develop rapidly, showing larvæ in about four days. They require exposure to air, and they do not seem able to begin their development in the horse. Experiments show that the larvæ die in water. It is practically certain that horses become infected as the result of swallowing water or food contaminated with the developing eggs. From these the larvæ hatch out in the intestine, settle down in the cæcum and colon, and after a number of moults become sexually mature.

Peculiar Rat's Teeth.—We discussed in No. XII. the overgrowth of a rabbit's incisor teeth, and we have since seen another specimen. A good case in an albino rat has been recently described by Hammett and Justice (*Anatomical Record, September* 1923). The lower incisors had failed to develop; thus the upper incisors were unopposed, and had grown round in an almost perfect circle. The rat was 287 days old, and it is interesting to notice that it was about 56 per cent. below the standard weight and 10 per cent. below the standard length. This meant that it had not been able to eat enough of food. The symmetry of the overgrowth was noteworthy. The causes of the overgrowth are, according to Beretta (1913), of three kinds. There may be an absence of the upper or the lower incisor teeth, which should by their friction keep a check on the overgrowth of those opposing them. This was the case in the rat. Secondly, the overgrowth may be due to some deviation in the natural relations of the upper and lower jaws, as in the case of the rabbit we discussed in No. XII. Thirdly, there may be a constitutional prognathism or forward growth of the lower jaw, so that the lower incisors miss the upper incisors.

Mosquitoes in North Wales.—The word mosquito, which means "a little fly," is applied to many different kinds of gnats. The dapple-winged mosquito, the usual carrier of the malaria organism, is a particular species, *Anopheles maculipennis.* It is interesting to notice from Mr W. Rees Wright's careful survey (*Annals of Tropical Medicine and Parasitology*, 1923, xvii., 539-547) that ten different kinds of larval mosquitoes occur in pools and other watery places in North Wales, and that seven of these kinds have been captured as adults. They survive the winter in various stages, some as eggs, some as larvæ, and some, like the "dappled wing," as full-grown winged insects. There are thousands of Anophelines in North Wales, and, since the war, there have been many imported cases of malaria. But it is reassuring to learn that Mr Wright has not known of any locally-contracted cases of malaria within recent years. Long ago, however, malaria or ague used to be common in Wales, just as in many parts of England and Scotland, and there are records of the losses sustained when the disease interfered with farming operations. The mosquitoes remain, but they have ceased to be carriers of the malaria germ.

Wounds on Trees.—A tree is biologically like a house. It is a circle which many other life-circles intersect. Just as a house has its human inmates, its cat and dog, its rats and mice, its sparrows and swallows, its flies and cockroaches, its spiders and mites, and the like, so a tree may have its squirrel, its nesting bird, a hundred insects, a score of spiders and mites, its ivy and lichens, and more besides. We suppose that it would not be difficult to find fifty different kinds of living creatures closely associated with a tree standing apparently alone in the middle of a field. It is more than a tree—it is a menagerie.

Dr D. Keilin has recently found a number of very interesting insects which are characteristic of the oozing surfaces of wounds on trees. Thus there are a number of Dipterous larvæ, *e.g.*, *Dasypclea*, that feed on the exuding sap. Then there are some other Dipterous larvæ of carnivorous habits, *e.g.*, *Systenus*, that devour the vegetarian kinds. And then there are Protozoon parasites that live in the fat body of *Systenus*. And so it goes on, wheels within wheels.

Wheels within Wheels.—There is a fly that is very destructive to Japanese silkworms. In cold seasons the pupæ of this fly, *Ugimyia sericaria*, lie quiescent underground; and they are then attacked by a mite, that seems to be a new species, *Tyroglyphus muscæ*. The mite kills the fly, and that is all to the good. Unfortunately, however, nature does not load her dice in man's favour, for the mite goes on to attack the silkworm. Therefore the breeding chambers of the silkworms must be protected against the intrusions of the mite as well as against the intrusions of the fly.

Mites and Hive-Bees.—There are many different kinds of mites, and their inter-relations with hive-bees are diverse. Dr John Rennie and Miss Elsie Harvey, whose names are associated with Mr Bruce White's in the discovery of the mite that causes "Isle of Wight" disease, have put these inter-relations in some order. (1) There is the disease-causing *Tarsonemus woodi* Rennie, now called *Acarapis woodi*, living in the breathing tubes or tracheal system. (2) There are mites that feed on honey, pollen and the juices of dead bees. They are of course commonest in hives that are not kept clean. (3) There are predaceous mites that prey upon those we have just mentioned, and perhaps on the mite causing Isle of Wight disease. (4) There is one which is often carried about by the hive-bee, but perhaps casually—*Tarsonemus apis* Rennie. (5) There are two which use the hive-bee for transport, just as they also use humble-bees. It is likely that humble-bees are more profitable vehicles than hive-bees, for they go more among the herbage, whereas the hive-bees come mainly into contact with flowers and water. There are some mites that seem to be useful partners or commensals, but this is not known in connection with hive-bees. The study is an interesting one, for it illustrates the variety of linkages in the web of life.

Homing in Farm Animals.—Perhaps some readers might be

inclined to send "The Biologist on the Farm," through this Journal, any well-documented cases of horses, cattle, dogs, cats or other mammals finding their way home over strange country which they did not *actively* traverse on their outward journey. There are many instances at a more or less anecdotal level; but criticised cases would be of great interest and value. Some years ago an elderly cat was taken in a basket by train from Kirkcaldy to Cumnock in Ayrshire, to a lodge on the Marquis of Bute's estate. The cat did not approve of the change, and soon disappeared. A few days after it had gone, the owner heard from Kirkcaldy that it had turned up at its old quarters there!

It has been shown by careful experiments at the Tortugas that terns taken in closed baskets for a hundred miles from their nests will return in a short time over seas that they had never before visited. A percentage will return from eight hundred miles. In such cases there is no possibility of individual learning, nor of observations being taken on the outward journey. In the case of homing ants and bees the majority of the experiments go to show that there is individual learning of the topography of the region, and that various kinds of sign-posts, such as prominent objects, differences of light, smell traces, are of value, helped probably by some memory of muscular movements. In the case of homing pigeons there is some education on the top of inborn capacity.

CO-OPERATIVE BACON-CURING FACTORIES IN SCOTLAND.

H. M. CONACHER.

THERE has lately been manifest a movement among groups of Scottish farmers in different parts of the country interested in pig-feeding to set up co-operative bacon factories. This movement has followed a similar one in England, where several such enterprises have been considered or carried out in the last few years. No doubt the high price of bacon since the war has encouraged this. At the same time as the number of pigs in the country went down during the war through lack of the bought-in feeding stuffs, one would have thought that the British pig-feeder would have been able to get satisfactory prices for pork during the years in which there was still a scarcity of pigs. It must be kept in view that pig-feeding is in certain respects like dairying. If there is a good market for fresh pork, it hardly pays to go through the process of curing bacon, just as no dairyman who could sell all his milk fresh would trouble to have it made into cheese and butter. And in the case of pigs there is not often the inevitable surplus, which in the case of milk must be made into dairy produce, if it is not to be used for fattening calves or pigs. Hence it is areas not near a good pork market in which pigs are fed to be made into bacon and sausages. Denmark is more or less in this position. It is true that Germany did take a certain amount of the Danish pigs as

pork before the war; but since then the German market has shrunken. The Danes feed pigs because that branch of live-stock keeping goes with dairying, and they export the pig meat as bacon, because there is no home market or other near market for pork, but a fairly near one in Great Britain for bacon.

Ireland is not quite in the same position as Denmark; it is near enough to Great Britain to be able to send a good deal of its pig meat as pork. Some of the larger cities of the Midlands and the North have considerable sales of pigs at their market; Birmingham, which oversteps all the others, has a sale that at times in the year comes near 4000 head a week. The demand for Irish-fed pork in Great Britain is, in fact, big enough to make it difficult at times to buy pigs in the Dublin market for local bacon factories. At the same time, bacon-curing is an industry of fairly long standing in Ireland. There are, however, only two farmers' co-operative bacon factories in the territory of the Irish Free State; one at Wexford and the other at Roscrea, at the north end of County Tipperary. The Scottish Co-operative Wholesale Society have a bacon factory at Enniskillen in County Fermanagh. The more important bacon factories are at Limerick and Waterford. They are the property of ordinary capitalist owners, and the farmers have nothing to do with the factories beyond supplying the raw material.

In England the corresponding industry is associated with the North Wiltshire towns of Chippenham and Calne. It is true that the counties of Wilts., Somerset and Berkshire have been the area of pig-breeding and feeding for generations, but the Wiltshire factories do not draw their supplies only from the neighbouring counties. Among the co-operative bacon factories which have been started in England during the last few years may be mentioned those at Hitchin, Bury St. Edmunds, Eastleigh and Kidlington (near Oxford), Lenham, in Kent, and Lincoln. This represents a considerable movement, and it will be noted that the factories are not too near together, so that each should have a fair area to draw upon for pigs withont encroaching on a neighbour's preserves. It is understood, too, that all these factories are, or are to be, built on a scale which will admit of 500 pigs a week being dealt with.

The greatest single factor in the successful working of a bacon factory is a guaranteed adequate supply of pigs; and even a respectable average supply will mean that at some seasons of the year deliveries will be slack. Hence the distribution of factories should be determined by the available supply of pigs within the area from which any one factory may be expected to obtain its pigs; and the amount of the pig population of a country will give a rough idea of the number of bacon factories which it can maintain, regard being had to the market for fresh pork.

In this connection the statistics of the number of pigs in Scotland as compared with other countries give their own warning. Thus there were, according to recent statistics, in England rather more than two million pigs, about the same number in Denmark, about one million in Ireland, 200,000 in Wales and 180,000 in Scotland. As sows have two litters a year, and as pigs are ready for slaughter in six or seven months, it is safe to add 50 per cent.

to these numbers to get the pig population for the year. Even so the number of pigs in Scotland is scanty. Hence if all the available capital for starting bacon factories in Scotland were in the hands of one person, he would probably recognise that there was room only for a limited number of bacon factories in the country, and would carefully consider how many the pig industry would stand and how they should be distributed.

The matter, however, is not under the control of any one mind; and co-operative factories will in the nature of the case be started by groups of farmers each thinking only of their own area; and as projects of this kind are not necessarily entertained only by one or two audacious pioneers, but are rather in the position of being taken up by a number of groups at the same time, owing to the modern dissemination of ideas by propagandist suggestions, it is the case that several schemes are now being put forward in different parts of Scotland.

The scanty pig population of the country, however, at once exercises upon these schemes an influence not realised apparently by their promoters; for in each case a weekly total of 200 or 250 pigs is being spoken of as the likely average amount to be handled in the factory, at least at the outset. Now the kind of argument which people find so convincing against the small holding applies quite as directly to the small pig factory. If it is wasteful to have a pair of horses for a holding of 35 acres, it is not less so to be at the expense of building and equipping a bacon factory with accommodation and plant for the several processes involved, and of employing the necessary staff for handling less than 500 pigs a week. Apart from "oncost" charges the superior economy of labour in the larger factories is striking—indeed, it is only at the 500 per week level that a reduction in the cost of handling the material begins to show itself; whereas for the 800 and 1000 per week factory the cost of handling is about a quarter of the corresponding cost in the smallest type of factory. It must also be kept in view that, apart from changes on the fixed capital, a fair amount of circulating capital is required to pay for a considerable number of largish animals, whose flesh will not be sold for seven weeks.

It may be said that one must have small beginnings. On the other hand, a co-operative bacon factory should be in a position to know how many pigs they can reckon on, as the members of the Society should guarantee so many pigs a week. It is often the case that they do not do so, and the manager has to buy pigs in the open market as a matter of course, if the price at the time tempts members to sell their pigs for pork. Under such conditions a bacon factory is only a joint stock enterprise run by a number of farmers and hardly deserves the name co-operative. One of the arguments often used by advocates of farmers' bacon factories is that they enable farmers to get better prices than they are getting from the ordinary dealer. Those who are moved by this argument do not, however, always realise to what course they are logically committed. They will the end without willing the means. Hence in practice, they are found playing the factory off against the dealer and then again the dealer off against the factory. The common

practice, by which the manager of the factory announces from week to week the price which the factory will give for pigs, seems unsound. The shareholders should agree to seasonal contracts and take any surplus as a bonus, as is done in the case of co-operative dairying societies. Under such arrangement the promoters of the scheme would know from the outset how many pigs they could reckon on, and, as prudent men, would not start without a sufficient number to guarantee success. A recent Report to the Ministry of Agriculture contained an expression of opinion that the opening of a bacon factory always tends to make the pig population of a district increase. This may be; but this general consideration does not absolve the promotors of any given undertaking from counting their immediate sources of supply.

It may be said that the promoters would be justified in beginning with 250 pigs a week, if they saw a prospect of working up to 500. Will they then build and equip the factory from the outset for dealing with 500? If so, they will be losing money during the interval in which they are working up to that figure, which, by the way, is itself a fairly modest standard. It is more likely that they will build and equip the factory for 200 or 250; in which case they will find themselves within a fairly short time under the necessity of extending their premises and perhaps scrapping fairly new plant—for it is difficult to make the nice adjustments required, if you are going to allow for growth in a bacon factory, without making some sacrifice. Experience, indeed, suggests that a good deal of the provision, *e.g.*, for such processes as chilling, curing, etc., should be made at the outset on a scale representing the output which it is hoped to work up to as a standard; and in the case of a bacon factory this means a liberal allowance of space for such parts as the refrigerating chamber as well as actual machinery.

It was said in a recent article in an English agricultural paper that there was a danger in 1922 of farmers' bacon factories being put up in England without due consideration of these various points; but that last year this danger was averted by something like concerted agreement among the various promoters of schemes.

It is to be feared that in Scotland the various schemes have not been adjusted. Let us look at the figures in detail. A factory handling 500 pigs a week will dispose of 25,000 a year. In Scotland there are two principal pig-feeding areas: (1) the south-western counties of Ayr, Wigtown, Kirkcudbright, Dumfries and Lanark, where pig-feeding is associated with dairying, and where, according to the Board's statistics, there were 66,000 pigs in June 1923; and (2) the north-eastern counties of Aberdeen, Banff, Kincardine, Forfar and Perth, where at the same date 50,000 were returned. There is little connection with dairying in this area. If we add 50 per cent. to these figures, it appears that in the north-eastern area, if every pig fed went to a bacon factory, only three factories handling 500 pigs a week could be maintained. Under similar conditions the south-western area might keep four factories going. There is, however, of course no likelihood that all the pigs fed in an area will under any circumstances be sent to bacon

factories. The price for pork is usually about 10 per cent. above the price given for bacon pigs and may be higher. This fact will always draw a considerable part of the pigs raised in a district into the fresh pork market.

It is significant that no definite movement seems to have been made towards setting up a co-operative bacon factory in Aberdeenshire; yet according to the statistics of the Board there are about 20,000 pigs in that county in June, a greater number than in any other county along the East Coast of Scotland. At present a good part of the Aberdeenshire pigs are said to find their way to the Newcastle market to be consumed as pork. Apparently the Aberdeenshire pig-feeders are not so strongly discontented with the prices which they get at present as to overcome their hesitation to embark on a new kind of enterprise. Yet there does seem room for such an undertaking in Aberdeenshire, and it is a pity that apparently little is being done.[1] Indeed, on the figures given of the pig population of Scotland it looks as if there were room for two bacon factories in the East and North of Scotland and perhaps three in the south-west. There have been in existence for some time two factories in the south-west district, the Scottish Co-operative Wholesale Society's factory at Kilmarnock and Messrs Kirkpatrick's at Thornhill in Dumfriesshire. Further, as most of the bacon made in Scotland is made in this part of the country at quite small establishments, on a scale little above that of home-curing, it may be that there is not much room for further developments here. As regards the rest of the country, one hears of projects more or less mature for factories either co-operative or at least owned by a combination of pig-feeders (as the one shortly to be opened at Stirling), at Perth, Elgin, and somewhere on the Borders.

The distribution does not seem too happy; it is difficult to believe that factories at Stirling and Perth will not to a certain extent draw upon the same areas; and it is difficult to see where a factory on the Borders is going to get pigs in any number within a radius of thirty or forty miles.

So far this article may seem to suggest that the chances of successful curing of bacon in factories are limited in Scotland; but some facts on the other side should not be overlooked. Thus it is understood that generally it is not intended to cure "Wiltshire bacon," but to stick to the Ayrshire roll in the Scottish factories. This makes the process simpler, as Ayrshire bacon is not smoked.

Further the curing of Wiltshire bacon requires that the pig shall conform in the disposition of his muscular tissues and fat to the rectangular type of animal, which the Danes breed and feed. The Ayrshire roll can be cut out of a less standardised pig. It is beyond the scope of this paper to discuss the general suitability of the types of pig bred in Scotland for making into bacon. There is, however, an obvious difference between the methods of feeding followed in the south-west and north-east of Scotland respectively. In the former district, as already noted, pig feeding is associated with dairying; and the suitability for the production of a bacon pig on

[1] Since going to press we learn that there is a definite movement towards setting up a bacon factory in Aberdeenshire.

the diet thus prescribed seems well established by experience gained elsewhere. Whether the style of feeding commonly adopted for pigs in the east and north-east of Scotland is equally suitable for bacon will be ascertained by greater experience. There is no particular reason, however, to suppose that the right breeds of pigs are not kept in either area.

AGRICULTURAL EDUCATION AND RESEARCH IN DENMARK.

ALEXANDER M'CALLUM, M.A., LL.B.

OF the several causes which have led to the notable achievements of Danish agriculture in the last fifty years by no means the least important is education; not so much technical education either, as general education in what may be called the humanities. In his estimate of the value of education the Dane is no whit behind the traditional Scot, and, indeed, so far as the general spread of knowledge and of mental alertness and intellectual interest are concerned, the impression gained from a brief investigation is that in these respects Denmark is probably ahead of Scotland. The number of newspapers and periodicals and their wide-spread circulation are one obvious sign of this intellectual keenness and interest. Another is the amount of familiarity one finds in almost all classes with such foreign languages as English and German, and a third is the transparent and ingenuous pride the average Dane has in his national institutions, which he most willingly and politely explains and describes to the visiting stranger. The Dane is consciously and openly proud of his nationality and of the history and achievements of his people; and this corporate family feeling is both reflected in, and is re-acted on by, the education given in his schools and colleges.

The organisation of elementary and secondary education is on much the same lines as in Scotland. Elementary education is free and compulsory between the ages of seven and fourteen. There are secondary schools in the more populous centres and their pupils are classified into three groups—intermediate, modern and classical. A system of examinations qualifies pupils of these schools for entrance to the various technical colleges, to training colleges for teachers, and to the University. By means of bursaries, maintenance allowances, and free tuition, provided either from State or from district educational funds, necessitous students of merit have the opportunity provided to them of passing through the secondary schools, the technical and training colleges, and the University. In 1921–22 there were in the agricultural schools and colleges 476 men students and 98 women students holding State bursaries.

The elementary and secondary schools are administered by the Communal education authorities; the Colleges by special governing bodies; and the University by its Senatus. All the

educational institutions are supervised and in part financed by the Ministry of Education with the one exception of the Royal Veterinary and Agricultural High School in Copenhagen which is directly under the authority of the Ministry of Agriculture.

The general organisation of education is thus much like our own. External to this general system, however, though intimately related to it, is the special feature which gives to Danish education its peculiar character and individuality—the Folkhighschool. This type of school was originated in 1845 by one of Denmark's great men—Bishop Grundtvig. Their founder's aim was in the first place to foster love of country and national solidarity; secondly, to fit young people for their civic duties in a free, democratic State; thirdly, to equip them with the mental and physical qualities which would enable them to join with confidence in the daily struggle for existence; and lastly and chiefly, to instil in them the principles of religion.

It is safe to say that in the main this high ideal of their founder is still regarded as the end of the education given in the Folk-schools, and their influence on the youth—mainly the rural youth—of the country must be both deep and widespread. In 1921-22, 2444 young men and 2797 young women voluntarily underwent a course of instruction in these schools. The age of the students is generally from eighteen to twenty-five, although some may be under sixteen and some are as old as thirty.

In keeping with the intention of their founder the curriculum of the Folkhighschool of the original type is entirely general; it contains no technical or vocational subjects. General history, Danish language, literature and history, geography, English or German, mathematics, physics, statistics, drawing, singing and gymnastics are usual subjects for men. For women, general and Danish history, mythology, geography, geology, physiology, chemistry, arithmetic, drawing, sewing, singing and gymnastics are commonly included. In all schools the director and his wife exert a kind of parental influence and the atmosphere of the school is high-toned and religious.

Of this original type of Folkschool there are at present thirty-three in different parts of the country.

A later development was the introduction of vocational subjects into the curriculum, these being naturally agricultural; but the main part of the teaching still remained general in character. Of this second type there are twenty-six.

A third type is that in which the instruction is mainly vocational, *i.e.*, agricultural, though the patriotic and moral aim is not forgotten. There are twenty-seven such agricultural schools in the country. Besides these, there are sixteen schools which give a training in women's work.

Thus all told there are just over a hundred schools for young men and young women giving courses of from three to nine months duration yearly, and approximately 6000 persons are being passed through these schools each year.

A remarkable feature is that most of these schools are proprietary; they belong to the director who has either instituted or acquired the school. In the case of some of the older, larger, and more famous schools they have been acquired by and are run by an association—often of old students or of farmers or smallholders. Thus the Smallholders School near Odense was founded in 1908 by an association of smallholders for the training of smallholders' sons and daughters; and the Dalum Agricultural School also near Odense, founded in 1886 by the then director assisted by a number of farmers, is now the property of an association of former students.

The success of these schools depends mainly on the personality of the headmaster and his staff. Attendance being voluntary and the choice of a school being entirely free even to students receiving a subvention from State or Commune, a school is under the necessity of justifying its existence by the kind and character of the teaching it gives. It does not follow that because a school happens to be situated in a certain district, that therefore the young people of that district will attend it. Indeed, it is quite as common for them to go further afield, choosing a school in another part of the country for the sake of seeing something different from their accustomed surroundings and of meeting teachers and students from other palces. All of the schools are residential; no day students are admitted; the residence, indeed, is rightly regarded as part of the training. The living arrangements and furnishings are of the plainest and simplest description, and the cost of lodging, food and tuition is reduced to a minimum, being at present rates from 15s. to 16s. a week.

In most of the schools the staffs are small; the director, his wife, and one or two full time assistants overtake most of the teaching, with the help possibly of one or two visiting teachers. Their remuneration is, as a rule, modest, depending as it does mainly on the fees of the students, supplemented in the case of established schools by a small Government grant. This grant, which cannot without a special appropriation exceed 3000 kroner (say £150) a year, is paid to a school only after it has been carried on successfully for two years and has an average attendance of at least ten students. The grant is proportional to the expenditure on the school buildings, the teaching, and the school materials.

A noteworthy feature of these schools is the fact that except in two cases they hold no examinations and grant no certificates. The pupils attend to benefit themselves educationally, not to qualify for appointments. Their attendance is certified by the staff and by a local committee which reports to the Ministry, and the schools are occasionally visited by Government representatives.

The two cases in which examinations are held are as follows:—(*a*) several of the agricultural schools hold special courses of about a month's duration for students who seek appointment as milk recorders, and naturally these students have to reach a certain standard of attainment and are awarded certificates; (*b*) two

specially recognised dairy schools give courses of eight months' training to men and women butter and cheese-makers to qualify them as managers or assistant managers of creameries. They also must satisfy examiners of their technical skill and knowledge and are certificated according to their attainments.

Another feature of these schools which strikes a foreigner forcibly is that the teaching is almost entirely theoretical. Even in the case of the agricultural schools, with the exception of the special courses in dairying, there is no attempt at combining practical training with the theoretical teaching even although all the agricultural and many of the other folkhighschools have small areas of land attached, with farm buildings and stock. The opinion is strongly held that the practical side of agriculture must be learnt in day to day life on the ordinary farm and, obviously, with young men and young women of from eighteen to twenty-five years of age the schools are dealing with people who have had a great deal of practical training in their own home places. It may be worth noting that as far back as a hundred years ago the Royal Agricultural Society of Denmark organised a system of farm apprenticeship in which the youth served three years on three farms in different parts of the country, one year on each farm, partaking in all kinds of farm labour and receiving in return board and lodging and a small payment in cash—about £10 a year. He sends in to the Society yearly a diary descriptive of the farm operations and results. It is stated that about 2500 young men have been trained in this way. Under a law passed in 1898 the Government appropriate annually a sum of 5000 kr. to subsidise apprenticeship of intending smallholders in practical work.

But so far as the agricultural schools are concerned, and this is notably the case with the Copenhagen Agricultural College, there is no attempt at combining theory and practice beyond the usual laboratory courses and field and farmstock demonstrations.

The activities of the highschools are not confined to the long courses of from five to nine months' duration for men and the three to five months' for women. Many of them hold also annually a week's course for older people or a re-union of former students or special short courses from time to time, and these appear to be well taken advantage of with excellent results. The mere bringing together of people who as a rule lead comparatively isolated lives must tend to widening of interest, stimulating intelligence, and broadening sympathies, as well as increasing knowledge. This common life of the schools appears to create a taste for corporate action and discussion of problems, and consequently it is usual to find in village centres a public hall, which is the regular meeting place of a lecture society where lectures and discussions are held and where singing, gymnastics and dancing are practised by the young people of the district.

Naturally enough, many of these lectures deal with agricultural subjects and they are frequently arranged into courses. These

courses are usually given by the body of men known as agricultural counsellors, of whom there are over a hundred engaged under the Government, the Royal Agricultural Society, Local Agricultural and Co-operative Societies, and the Heath Cultivation Society. The first of these advisers was Professor Segelcke who was appointed in 1862 by the Agricultural Society to advise in dairying. He trained several assistants who were afterwards appointed by local societies. Later in 1876 the Royal Agricultural Society appointed an adviser in animal husbandry and in 1872 one in plant culture. About 1888 the State organised a small body of highly-skilled advisers and these are now as follows:—One in agricultural chemistry, two in plant culture, four in animal husbandry, four in dairying, two in agricultural machinery, one in horticulture, one in plant diseases, one in agricultural and forest zoology, and three resident in England, Germany and America to represent the interests of Danish agriculture in the countries named. The salaries and expenses of these particular advisers are borne by the State. The State also contributes a proportion of the expenses of the advisers appointed by associations. All these advisers make annual reports relating to their respective subjects to the Ministry of Agriculture. They appear to have exercised a considerable influence on the development of the national industry. They reach their clientèle both by teaching in schools and lecturing in the village meeting halls and by visiting and advising them on the farm.

The nerve centre of all this agricultural teaching and advisory work is the Royal Veterinary and Agricultural High School in Copenhagen. This is entirely a State Institution, and it was founded in 1856—opened in 1858—to provide higher training for veterinarians, agriculturists, horticulturists, forestry experts and land surveyors.

So far as agriculture and horticulture are concerned the training is entirely theoretical; the assumption being that the student has obtained a sufficient knowledge of practice to enable him to follow the theoretical course. Most of the students in agriculture have three or four years practical training before entering. In the veterinary and land surveying courses a certain amount of practical or clinical training is included.

Before entering upon any of the certificate courses students must pass an entrance examination which varies according to the course taken. Thus the veterinary student must show knowledge of three languages other than Danish, one being Latin. The agricultural entrance examination is much less exacting, and, moreover, one may attend the courses as an "extraordinary attendant." Only students proper—*elever*—can sit for scholarships and have also the right to take an examination at the end of one of the four advanced courses which follow the general course.

The "general" course in agriculture embraces lectures and examinations in the following subjects:—Physics and meteorology, chemistry, soils, botany, zoology and agricultural zoology, anatomy,

animal husbandry, mechanics, soil culture, cultivation of farm crops, dairying, agricultural book-keeping, plant pathology, general agriculture.

In chemistry, botany, surveying and agriculture (including stock-judging) a good deal of time is devoted to laboratory and demonstration work.

This general course extends to twenty months. Twenty so-called "characters" or passes in separate subjects are awarded on examination in the various subjects; nine being given at the first examination and eleven at the final examination.

Following upon this general course there are four special courses in (*a*) fundamental sciences; (*b*) science of agriculture; (*c*) animal husbandry; (*d*) dairying. These courses are arranged in such a manner as to include with the main subject of study certain allied subjects. They are intended to equip specialists in the different branches for research, for teaching and for advisory work. The instruction given in these special courses is more of the nature of tutorial guidance than lectures and the students are required to work out independently sets of exercises on problems set by the professors. The duration of each course is twenty months.

To enable students of moderate means to follow the various courses at the Royal High School there are numerous scholarships available; usually about one-fourth of the total number of students are bursars, of whom possibly one-half may get the full scholarship allowance of about £5 a month, with free tuition and travelling expenses in addition.

So far as the general course is concerned there is not a great deal of difference between the Danish curriculum and our own. The former as will be observed is a little more subdivided, and some advantage must accrue from the fact that certain branches are dealt with by specialists, whereas in our Scottish Colleges we have been accustomed to have one professor dealing with the whole range of agriculture cultivations, crops and animal husbandry.

The provision of advanced specialist courses is a feature of special importance in the Danish system which hitherto has been lacking in Scotland. Recently, however, provision has been made for the introduction of this feature in the Honours Degree Courses at Edinburgh and Glasgow, and we may hope to find these taken advantage of by students who look forward to appointments as teachers or advisers, or research workers.

Agricultural Research.

Agricultural research in Denmark is in the main a State affair. A considerable amount of experimental work is certainly done by the various associations of farmers, but even in these cases as a rule the State makes grants in aid; and the tendency appears to be for the State to finance the more purely scientific research work and to keep the control thereof in its own hands.

The Experimental Laboratory of the Royal Veterinary and

Agricultural School in Copenhagen may be regarded as the leading institution in Danish agricultural research. Its special sphere of operation is animal nutrition and dairying research. The Laboratory was founded in 1875 by Professor N. J. Fjord and began with experiments on milk preservation. This led on to researches into methods of butter and cheese making, and later to experimental feeding for milk production. The actual feeding experiments were and are carried out on numerous farms and the results are tabulated and reported on by the Laboratory. In this way the interest and sympathy of the farmer have been maintained in scientific work. At the Laboratory itself there are chemical, bacteriological and animal physiological sections in which laboratory experiments are conducted conjointly with those carried out on the farms or in the dairies. Besides the research work proper, the Laboratory organises butter tests taken part in by about 1400 dairies all over the country, each dairy undertaking to send in on demand about 50 kilogrammes of butter in order that the Laboratory may judge of the quality of the butter as suitable for export. The test is made fifteen days after the date of dispatch from the factory so as to test keeping quality.

The practical utility of the Laboratory to the dairying industry is shown by the fact that the general practice of centrifugal creaming, pasteurisation and the proper ripening of cream, is in the main the result of the work of the Laboratory.

The feeding experiments originated in the necessity of comparing from the nutritional point of view separated with hand-skimmed milk as fed to calves and pigs. They have now branched out into all nutritional problems of cattle, horses, pigs and poultry and also into the slaughtering and salting processes in the bacon factories.

In the physiological and pathological sections of the Institute, which were instituted in 1908, researches are conducted into diseases of domestic animals, and serums, vaccines and other bacteriological preparations are made up and issued. Such diseases as epizootic abortion, tuberculosis, strangles, swine-fever, braxy, pleuro-pneumonia have been specially dealt with. The annual expenditure on this branch amounts to about £3000, but some part of this is met by the sale of vaccines.

The Dansk Frøkontrol or Seed Testing Station was founded in 1871, as a private enterprise by E. Møller Holst, and was taken over by the State in 1891. The tests give information regarding (*a*) genuineness and place of origin; (*b*) purity; (*c*) weight; (*d*) vitality and germinating power.

The Seed Control is located in a special building in Copenhagen and has a staff of director, three chief assistants, and twenty-six assistants. The expenditure runs to about £2000, of which nine-tenths or over is covered by fees received for analysis.

An Advisory Committee appointed by the Ministry of Agriculture practically administers the affairs of the Seed Testing Station. The Committee consists of two representatives of agricultural science, two farmers and two seed merchants.

A similar body—the State Plant Breeding Committee—looks after the administration of the activities of the Plant Breeding Stations. This Committee, is composed of three members, elected respectively by the Royal Danish Agricultural Society, the Royal Veterinary and Agricultural High School and the Central Association of the local agricultural societies. The Committee forms the link between the Ministry and the Stations, approves plans and budgets, publishes the journal and reports, and generally supervises the whole arrangements. The appropriation from the State administered by the Committee amounts to about £12,000 annually.

The State Experimental Plant Breeding Stations are six in number, with two sub-stations, and they are distributed throughout the country, on representative soil types. Experiments dealing with cultural conditions of interest to the whole country, but which are assumed to be affected by the soil and climate of the various districts, are carried out at all the stations simultaneously. This is the case with species, varieties and families of cultivated plants, seed breeding, time of sowing, amount of seed, methods of sowing, soil culture, soil improvement, rotations, previous cropping, manuring, control of plant diseases, etc. On the other hand, experiments not dependent on local conditions—such *e.g.*, as manure conservation are made at one or two stations only.

The directors of the stations are appointed by the Ministry, and each is responsible for the running of his station. A common plan of work is drawn up by a conference of directors for each year's experiments, and detailed regulations are laid down for the starting and conduct of the trials during the season. The results of common experiments are compiled by one of the directors, who prepares a report which, when approved by all his colleagues, is published in the *Tidsskrift for Landbrugets Planteaval* —the journal of the stations.

Local plant-breeding work is also carried on by over one hundred local agricultural associations, special attention being given in these to cultural conditions affecting a small area. These experiments are usually run under the advice and supervision of the agricultural counsellor for the district or local associations. State subsidies are given in aid of these experiments to the extent of one-half of the approved expenditure.

In conjunction with the agricultural plant-breeding work, soil sampling and analysis are undertaken in the State Laboratory at Copenhagen, lime deficiency being specially dealt with. Work is also in progress on the nutritive value of forage plants at different stages of growth. Analyses of manures and feeding-stuffs are made by authorised chemists in different centres, their laboratories being subject to State supervision.

Since 1892 the State has made an annual grant of about £250 to the Royal Agricultural Society to assist in meeting the expense of trials of agricultural machinery and implements.

More recent additions to the State institutions for agricultural

research are the Phytopathological Institute at Lyngby and the Dairy Institute at Hillerod. The Phytopathological Institute has a staff of director, two sub-directors, three assistants and two groundsmen. The building, just completed, was erected by the State at a cost of £16,000, and the annual maintenance runs to about £3000, also provided by the State. The station carries out research into insect and fungus attacks, publishes leaflets, advises farmers, conducts educational campaigns at agricultural shows and other meetings, gives demonstrations, supplies certain insecticides and generally wages war on plant diseases.

The Dairy Institute and Experimental Dairy at Hillerod has just been established by co-operation between the State and the dairy organisations, each providing half the capital outlay on building and equipment, the State's share amounting to over £25,000. In addition the State has attached to the Institute two farms with a stocking of 250 cows, the milk of which is all supplied to the Institute.

There is no State institute dealing with problems of animal breeding, but the State gives subsidies to several agencies whose object is the improvement of farm stock. Thus 40,000 kroners annually is offered for premiums for stallions over four years old, while premiums for mares and young stallions are offered, and of the amount so offered the State provides one-half. Horse-breeding associations are given a grant of not more than 2000 kroners for each stallion kept by them, and there are about 280 such associations with one or more stallions each.

Grants are also made to cattle-breeding and milk-recording societies. Danish cattle cannot get a prize at a show without a record of milk production and pedigree. Aged bulls too are compared by investigation of the records of their progeny.

The Government interest themselves in the swine-breeding industry, and certain herds are after examination certified as "State approved breeding centres." Of such centres there are about a hundred scattered over the country, all under the supervision of the experimental laboratory of the Royal College.

With respect to forestry it is to be noted that a considerable area of woodland in Jutland and Sealand is State-owned—close on 200,000 acres. The Ministry of Agriculture is the administrative body, with a director over the twenty-four districts, each of which is managed by a wood ranger and assistants. Experiments relating to forest management are controlled by a commission in which are representatives of the State and of the private owners and the timber industry. Planting of sand dunes and heaths is under special supervision. Heath plantations of five and a half hectares or over may be registered as "conserved" woods, and so secure a State subsidy of one-third of the total expenses.

Higher forestry education is given at the Royal College; the course covers six years, two of which are spent in the wood districts. The training of the under-rangers is in the care of a board of training appointed by the Ministry of Agriculture; the

course occupies three years, and most of it is taken up with practical work in the woods and nurseries.

Horticulture has three State experimental stations devoted to it, one on the mainland near Esbjerg, one near Odense on the island of Fyen and one at Hornum in Himmerland. Horticultural experimental work is also carried on at the Royal College in connection with the course in horticulture. Its interests are also the object of the National Danish Gardeners' Association for market gardening, and of the Royal Danish Horticultural Society for private gardening.

The strongest impression one gains in such a survey of Danish agriculture and education as was possible on a short visit is perhaps the evidence of careful and deliberate organisation. A remarkable feature to a Briton is the manner in which people in Denmark have become accustomed to doing things for themselves. They get together and form a society for the purpose of attaining their object on their own initiative, and they do not in the first instance call upon the State to set the movement going.

On the other hand, it has been long recognised in Denmark that the State has definite functions and a clearly marked sphere of action in the organisation of agriculture, including agricultural education and research. A deliberately considered national agricultural policy has been adopted and every means of promoting the policy is tried.

In this connection the system of referring the guidance and supervision of branches of agricultural investigation to committees of experts seems worthy of imitation. Instances of this reference are the Plant-Breeding Committee of seven members appointed by the Government, some of them specialists on the scientific side and some of them representatives of agricultural associations; the Committee on Animal Husbandry; and the Committee on Dairy Husbandry. This co-operation of the State with industrial representatives appears to work well, and to be productive of the best results.

While it is not suggested that the system of folkschools should or could be established in all its details in Scotland, it does seem a pity that we have practically nothing of this type of educational agency. We have made a beginning with the Rural Economy School at Aberdeen, and it will be interesting to watch the result of this experiment. But there ought to be in our scheme of education a place for institutions of the Danish type for young men, where they would live together for a few months under careful supervision, and where they would accustom themselves to discuss matters of common interest, would get into the habit of acting together, and would develop such a corporate feeling as that which is at the root of the whole co-operate movement in Denmark.

FARM PESTS.[1]

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BIRDS.

The Reading of the Results of Food-Analysis.—Suppose that, having followed the method of examining in detail the food materials in the crop of a particular species of bird (after the manner I have described in the preceding article), we find ourselves in possession of a mass of information indicating the feeding habits of the species throughout the year. Are we now in a position to decide the birds' agricultural standing? Unfortunately we are far from being able to make any such definite deduction by scientific reasoning. For although the discoveries of food-stuffs are of prime importance, and, where they are tabulated in detail after the numerical method, afford a solid basis for further examination, the simplest form of statistical enquiry demands that many precautions must be taken, even before a food-average for the species can be struck.

A general article, such as this is intended to be, is no place for the detailed consideration of these precautions, but since they do not seem to have entered into the calculations of the food-averages that have been published, a reference to some of the difficulties that arise from the miscellaneous collection of birds for examination, will at least indicate the extraordinary complexity of the subject we are discussing.

In the first place I am strongly of opinion that for the purposes of bird-food enquiries, agricultural areas should be broadly classified according to their predominant character, say into arable areas, pasture areas, fruit-growing areas, and so on. Each of these should be regarded as separate entities from the birds' food point of view, for examination has shown that the same species of bird may consume different food in each area, that is to say its agricultural significance may be entirely different according to the nature of the area in which it occurs. In such cases no method of averaging food consumption can result in a general truth applicable to each area and all the areas. In other words it is absurd to expect the fruit-growers of the south to protect the missel-thrush, which does serious injury to their crops, because in agricultural areas the bird is distinctly beneficial. Even if, on the average of the whole country, the missel-thrush proved to be beneficial, it would still be unreasonable, on the grounds of an abstract average, to protect it in the fruit areas. Such a course could be justified only on the assumption that the whole country was a unit area over which the birds freely roamed at all seasons of the year; but there are no grounds for such an assumption, since during a great

[1] Articles in this series, dealing with Mammal Pests, appeared in the *Journal*, beginning with the July number, 1922. The first article on Bird Pests appeared in the January number of the present volume.

part of the year birds are permanent residents in the district in which they have settled.

In the second place a great difficulty arises from the nature of the food itself. It has been the universal method to sum up the total amount or total volume of any particular kind of food, for the round of the year. Although this may be an entomological or botanical point of view, it is not an economic one; nor is it the farmer's view of relative values, for it suggests a totally false uniformity of agricultural values throughout the farming seasons. Take a simple case in illustration: the number of grains of oats found in the food-canals of a series of rooks, killed in all months of the year, is added up, and the total is set against the rook as part of its infamous work. Is this fair? Surely the grains found in the stubble after the crop has been harvested are of no agricultural value; surely the oats eaten by rooks, or other birds, from late September till February should be deducted from the accusing total, and be regarded as, at any rate, a neutral quantity. So also with the oats picked up on the roadway or at the railway siding—all of which have been reckoned against their consumers. Again, ought we not to place in different categories of value the oat-grain taken from the ripening ear or the stook, a grain which may fairly be reckoned as a single grain, and the grain stolen from the seed-bed, in which lies the potentiality of say a twenty-fold return? In fact we really ought to know where and when each bird examined has been feeding, not in order that it may be eliminated from the series, but in order that rational allowances may be made for the character of the food it has eaten.

Where animal food comes to be considered, the difficulties of making an analysis which could be regarded as of rigid scientific value seem to be insuperable; and yet it is plain that the destruction of an injurious insect, which has laid its eggs and is about to die, cannot be compared agriculturally with the destruction of the same insect, fertilised and ready to deposit its scores of eggs in as many scores of plants, most of which will suffer from the ravages of the larvæ when they emerge. All that we can say at present is that insects found in the stomachs of birds in early spring, immediately after their appearance from the winter's rest, are probably of very much greater agricultural significance than examples of the same species destroyed in the autumn after the last brood of the year has appeared.

A third difficulty seems to me to render almost meaningless these minute balancings between beneficial and injurious food, which have been widely adopted by workers in this field. The difficulty arises from the fact that the food-stuffs of many species are of the most diverse kind, and afford no common denominator for comparison. And here, in my opinion (though many expert economic ornithologists would disagree with me) the method of reckoning food-contents by volumes serves only to make matters worse. No useful comparison can be made between a volume of insects and a volume of vegetable food, since there is no common

basis for comparison. Take a simple imaginary example: a rook is found to contain, say, four wire-worms and an equal volume of barley grains, and because both volumes are equal and one represents a service to agriculture and the other a disservice, we are inclined to say that the good balances the evil and the activity of the bird, so far as our examination goes, is neutral. But have we any reasonable ground for making such a comparison? We have none, for a wire-worm has no simple relation to a corresponding bulk of grain. A wire-worm is a long-liver, and during its prolonged occupancy of the soil (for two or three years) it may, by cutting the roots of the barley, destroy not its own bulk of grain, but something vastly greater, certainly many times its own volume. Before we can hope for any convincing scientific reading of food contents, we must reach a means of equating the farm pest and the destruction it causes. After much observation and labour, having allowed for probable actual destruction by one individual, probable annual progeny (and its destructiveness) and so on, we may be able to construct a table which will read after the following fashion:—

1 wire-worm = 200 grains of crop barley, 100 grains wheat, 50 grains oats.
1 turnip flea beetle = 3 turnips.
1 cabbage maggot = 2 cabbages.

Then and only then shall we be approaching a position when the food contents of a bird can be interpreted with exactness. Till that time arrives, all we can do is to take for granted as obvious, from a knowledge of the natural history of insect pests, that, if a bird devours a volume of injurious insects and an equal volume of useful vegetable matter, it is much more likely to be a benefactor than an enemy to the farmer.

Lastly, there is a statistical difficulty in reading the result of food-content counts, that has not been faced by the economic ornithologists. It is the custom to add up the total number of birds examined, irrespective of the fact that casual collecting often results in very unequal numbers being obtained in different months. Surely *each month's* numbers should first be reduced to an average and this average should then be brought into relation with the number of birds present in the area in the various seasons, before any accurate average for the year can be computed.

But in spite of these difficulties, which lie in the way of an *exact* analysis, it is still true that a *general* reading of food-contents may show that certain birds are on the whole clearly beneficial to the farmer and that others are on the whole clearly harmful. It is in the border-line cases, where controversy rages, that the food-contents results must be interpreted with the greatest care, and must be regarded, not as scientifically infallible, but as offering no more than hints to the student of farm economics.

Miscellaneous Destructiveness.—Although the food of birds may in many cases betray the economic significance of a species, there are other cases where very serious damage may be done

which is unrepresented or inadequately represented in the food bill. An example or two will illustrate the need for a wide survey of a bird's activities, before final judgment is pronounced.

The wild grey lag-geese, which visit the ripening corn fields of the Outer Hebrides in early autumn, not only consume the grain, but make deliberate and concerted efforts to beat down the standing corn so that they may more easily reach the ears. A flock will rise in the air and alight in a pack in some selected section, or individuals will beat the corn with their outspread wings, so that the harm caused through the "laying" of the oats exceeds the harm caused by consumption alone. So grouse and black-game may, under certain seasonal conditions, defile by their droppings and shake by their alighting many more ears of stooked corn than they actually eat.

The capercaillie and black-game may contain traces of pine-shoots amongst their food, but this little represents the loss sustained by the forester should the leading shoots of his plantations have contributed to the diet. Ravens, hooded and carrion crows, and even great black-backed gulls, may destroy weakly lambs for the sake of a succulent morsel, such as an eye or a tongue; and certain hawks, carried away by the lust of slaughter, are said on occasion to destroy more grouse than they can consume.

Again, many birds that are generally reckoned as weed-destroyers, might be more aptly termed weed-distributors. Often weed seeds swallowed by a bird are neither broken nor digested sufficiently to prevent germination, and the result may be a fresh crop of undesired plants wherever the bird deposits its burden. In my own limited town garden I can gather any spring a score or two of seedling elders, springing from the soil beneath branches where sparrows, blackbirds and song-thrushes have perched. And there is abundant evidence that a large variety of weeds, such as plantain, chickweed, sorrel, daisy, yarrow, groundsel, charlock, knotweed and many more, may thus be spread in new areas through the agency of different common birds.

The Final Judgment.—The economic status of most birds is, it will be seen from the foregoing remarks, no easy thing to compute. We start with the assumption that birds should be classified as useful or harmful, as pests or friends, but such simple classification is foreign to the ways of nature, and we are compelled to confess that, with a few exceptions, a bird may be both useful and harmful, if not at one and the same time, at any rate at different stages of its career. Our conclusion must be reached in no haphazard way: many a species is condemned after the examination of the food-content of an individual caught in the evil act; but such general condemnation is no more reasonable than would be the condemnation of the human race as thieves, because one man had been discovered with stolen goods. To sum up, we must allow that the service of any bird is not a simple unchanging quantity, that its food is indeed a highly complex

quantity, varying from district to district, and from season to season, changing, even in the same species, with the soil, the climate, the staple crops, and also with the numbers of its own kind and of other species which compete for the same sort of food.

Only patient summing of much and varied evidence from all relevant sources, patient balancing of the pros and cons, can result in any kind of final judgment likely to appeal to the fair-mindedness of men, whether they be farmers or scientists.

In view of the difficulty of interpreting in detail and with exactness the diet of birds, it is the more necessary that account should be taken of the broad effects traceable to the presence or absence of particular species. If the persistent destruction or absence, for one reason or another, of one kind of bird is reflected in the increase of certain insect pests, or if the development of an insect plague is obviously checked by certain species of birds, such evidence must be regarded as of prime importance in deciding the economic *rôle* of the birds concerned.

The Law and Bird Pests.—A word on the subject of the laws which affect bird pests may not be out of place, if only for the reason that, because of the law, the farmer is not always at liberty to interfere with such birds as he may regard as harmful.

In ancient Scottish law bird pests stood in a position very different from that at the present time. There was then definite provision made for the keeping in check of specific pests. Thus rooks were dealt with, as early as 1424, on the ground that "ruks bigande in kirke yards, orchards or trees does gret skaithe apone cornis," an enactment to which further reference will be made in discussing the status of the rook in the economy of the farm. And in 1457 a further law provided for the destruction of "birds of riefe," or thieving birds, such as "ruikes, crawes, eirnes [eagles], beisettes [buzzards], gleddes [kites], mittales [hawks], the whilk destroys beast, corne and wild-foules." In these days few birds were protected: the main provisions related to game birds and to wild fowl, which were valuable to man as food, namely, such "as gainis to eate for the sustentation of man, as pertriches, plovares and sik like foules"; but there were also odd local enactments which protected such birds as ravens in Berwick-on-Tweed, because of their value as scavengers, or great skuas in Shetland, because of the services they rendered the farmer in driving away eagles.

Nowadays the legal position of birds in Britain is almost exactly reversed. The old standards have disappeared, owing largely to a change in the numbers and distribution of birds since the early days, and partly to a change in the sentiment regarding birds, induced to some extent by witness of the gradual extermination of many species. So that, instead of proscribing many birds and protecting few, the legislation of to-day protects almost all the resident species and actively penalises none of the birds formerly regarded as pests.

Since, then, the farmer is not compelled by law to destroy any bird pest, his attention must be confined to seeing that, in

destroying birds which he regards as pests, he is not infringing the protective laws of the country. These laws fall into two groups—the game laws and the Wild Birds' Protection Acts. The "game" that concerns us here, as defined in the Game (Scotland) Act of 1832, comprises pheasants, partridges, grouse, ptarmigan, heath or moor game, black game, wookcock, snipe, quails, landrails and wild duck, and the right to kill such game is a "right incident to feudal property in land at common law, and every person possesses it on his land in virtue of his right of proprietorship." This right falls to the tenant or occupier of the land unless he has relinquished the right by agreement. But even the occupier or the owner or his lessee may not kill game during a statutory close time each year, varying in the case of different species, from 11th December to 11th August in the case of grouse, 2nd February to 30th September for pheasant, or to 31st August for partridges, and so on. Further, no game mav be taken on Sundays or on Christmas Day, and both a game and a gun licence are essential.

The Wild Birds' Protection Acts, nine in number, deal with the birds which do not fall into the category of "game·birds." All such birds are protected during a close time or "breeding season," which normally extends from 1st March to 1st August in each year, a period which, at the request of County Councils, has been modified in certain areas. During the close time it is an offence for any person to take or kill any wild bird, with an important exception, namely, that in the case of unscheduled birds the owner or occupier or his agent is exempted from the prohibition. As regards the birds whose names (eighty-five in number) appear in the schedule to the Act of 1880, it is an offence for anyone, without exception, to kill or take any of them during the close season. Unfortunately for the simple working of the Acts, the Home Secretary or Secretary for Scotland was empowered, at the request of a County Council, to add to or subtract from the list, as well as to modify the protection of birds and their eggs in various ways. The result is that almost each county has its own local "Orders," which supplement or modify the provisions of the national Wild Birds' Protection Acts.

What facilities are given by these Acts for dealing with bird pests? They are largely of negative value, but of considerable importance. In the first place, outwith the annual close time, any pest, scheduled or unscheduled, may be killed, provided it has not been given special protection by local order made at the instance of the County Council. In the second place, even during the close season, unscheduled pests may be dealt with by the owner or occupier or his agent. And who better than the owner or occupier is competent to deal with such? Any further extension of this privilege to outsiders would tend to encourage trespassing. In the third place, it is open to a County Council, acting on behalf of its constituents, to request the proper authority to remove proved pests from the schedule, as applying to its own area; so that it is possible for the owner or occupier to deal in this way even with a

bird scheduled in the Act of 1880. Several Scottish County Councils, adopting this plan, have had all gulls, except the black-headed gull, removed from special protection.

As regards one type of pest, however, the law is unsatisfactory. There is no provision made for checking the ravages of a rare bird which has so increased in numbers in a local area as to become harmful. Suppose that in a certain district of Perthshire or Argyllshire the golden eagle so multiplies that its presence becomes a menace to the safety of the hill flocks. The only method of dealing with such an event under the present law is to remove the golden eagle from protection throughout the whole county. But so drastic a step might easily lead to the extermination of the bird in the county, and would check any spread of the eagle to new areas where it might be harmless. An attempt to meet this unsatisfactory position by providing a simple method of dealing with local pests which, outside the pest area, are worthy of protection, was made in a new Wild Birds' Protection Bill introduced by Lord Grey of Falloden to the House of Lords in 1923. The clause in question provides that the Secretary of State shall "have power to grant a licence to kill or take birds, or to take the eggs or nests of birds . . . . for the purpose of the protection of property, crops or fisheries, or for any special purpose approved by the Secretary of State." The bill containing this provision passed through the House of Lords in 1923, but has not yet been introduced to the House of Commons. Such a provision, however, ought to simplify and legalise the destruction of birds which are rightly protected over a large area, but which have developed in certain circumscribed areas into local pests; always provided that the granting of a licence for the destruction of such pests can be carried through rapidly, without the intervention of delays which might well render the licence valueless for its particular purpose of protecting stock or crop.

Other countries have gone further than Great Britain in their legislative attempts to deal specifically with birds of agricultural importance. In Germany the position is controlled by the Imperial Law of 1888, which details in a schedule, not the birds to be protected as does British law, but the harmful birds which ought to be destroyed. This "black list" includes the diurnal birds of prey (except falcons), the eagle-owl, shrikes, crossbill, sparrow, crows, pigeons, moorhen, coot, heron, goosander, gulls, cormorants and grebes. In the majority of the other European countries recent legislation is based on the findings of the International Convention for the Protection of Birds, held in Paris in 1902. This Convention, the findings of which were officially accepted by practically all the European countries, with the exception of Great Britain, Italy, Holland and Russia (although Italy fell into line in 1915), drew up two lists of birds, a longer one of those regarded as useful from an agricultural point of view, and a shorter list of noxious birds, covering some thirty to forty species.

As a rule the laws which have been formulated give general protection to insectivorous birds. While some mark out for destruction a formidable list of pests, it would be a mistake to suppose that these lists could usefully be transferred as they stand to Britain. For, as I have already pointed out, not only is the economic significance of a bird a factor dependent upon the general agricultural modes of a country, but it is often even minutely dependent upon strictly local conditions. In this respect, then, the open position retained by British law is preferable to the hard and fast "black list" of the continent, provided sufficient freedom is given for the local destruction of pests whose harmfulness has been proved to exceed their usefulness.

Methods of Dealing with Bird Pests.—In the subsequent accounts of the various bird pests there will be indicated the means generally adopted for keeping each pest in check. Here I would simply mention in a general way the kinds of methods in use. These methods fall into two groups, destructive methods and scaring methods.

Of all the methods, shooting the adult or fledged birds is that most widely practised. The shooting may be a casual affair, the dealing with a pest at convenient moments, or it may develop into a carefully organised attack, as is usually the case in reducing the numbers of birds in a large rook colony. But, as well as destruction of adults, destruction of eggs and of nestlings, either by shooting or by pulling down the nests, is often resorted to.

Another destructive method largely employed, especially in certain districts of England, is netting. But netting demands both skill and patience, as well as a certain amount of special apparatus, so that farmers generally hire for the purpose professional bird-catchers. So great is the desire for their services that London bird-catchers travel even as far as Lincolnshire to catch linnets damaging mustard seed, and although their wages often consist only of the birds they catch (and subsequently confine in cages), in many cases the farmer recompenses them for the destruction of sparrows, starlings and greenfinches. In addition to their nets, bird-catchers also make use of bird-lime, spread on straws on the ground or on the twigs of trees, to which the wild birds are attracted by captive call-birds.

Many modes of scaring birds have been tried in many countries, but few have been found to be permanently successful. The reason is not far to seek. Scaring methods are essentially attempts at bluff, endeavours to frighten birds by suggesting by appearance, by noise, or by movement that some enemy is at hand ready to fall upon them. The trick often fails because we underestimate the 'cuteness of birds and their ability to benefit by experience; "muckle bark, little bite" is a lesson learned by birds as well as by men. So it is that the most venerable of scare methods, the scare-crow, falls flat even after a very devastating *début* in a threatened field, and for the same reason birds learn to brave the mechanical noisy windmills and the swinging strips of mirror-glass that cast

sudden flashes of sunlight along the rows. Indeed, because of the 'cuteness of the birds, it is a safe rule that a scare method must be employed only for a crop that requires temporary protection, else its period of effectiveness may have run out before the crop has grown out of danger.

So long as their temporary value is recognised, several scare devices may be adopted with good effect. It is almost essential, however, that they possess irregular movement or create noise, or combine both functions. Dead crows hung from a stake so that they twitch and turn with each breath of wind, and many artificial devices of the same nature, floating streamers of ribbon or of worsted fastened well above the ground to stakes, disturb the thieves at their thieving or prevent their alighting. French agriculturists sometimes perch on a high pole stuffed specimens of hawks or the larger owls, though these would be much more likely to be effective were they suspended with wings outspread in such a way that they swung or pirouetted in the wind. Another French device said to give excellent results is the suspension of sheet iron silhouettes, cut and painted to resemble cats. The images are hung by a length of twine so that they swing freely about half an inch above the ground, and their position in the field is changed each day, after dusk has fallen. They are said each to protect a circle of over thirty yards radius.

A less mechanical method of scaring is the use of heavy, loud sounding clappers carried and worked by a farm hand. This method is extensively employed in parts of England, but its efficiency is in direct proportion to its elimination of the mechanical element, that is to say its value depends almost wholly on the activity and alertness of the boy; and that is precisely the strength and the weakness of the human bird-scarer.

THE MICHIGAN LAND ECONOMIC SURVEY.

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THERE is to be found in America as, indeed, in many other parts of the world, vast areas of land which are either derelict or are not being utilised to the best advantage. There are, for example, abandoned farms, forest land on which the trees have been cut or burned down and undrained swamps. Besides this definite waste, there are certain areas which could be devoted to growing crops more valuable than those which they at present produce, and others which lend themselves particularly to industrial development.

In many parts of the United States the natural store of plant food in the soil has long since become exhausted, and farmers have found it no longer possible to grow remunerative crops without

returning something to the soil. While there was plenty of virgin land farther west, it was a common practice to leave farms which were becoming exhausted and migrate to the areas which still contained all their natural resources, and would grow good crops without the aid of fertillisers. This migration left a trail of derelict farms in certain parts of the Eastern States, and the reclaiming of these has been one of the problems undertaken in recent years. The reasons for these farms becoming derelict have been various. Frequently it was a case of exhaustion of the soil humus or lime, with the result that it became unprofitable to continue growing grain. In adjacent farms where natural conditions have been somewhat different or where the fertility has been conserved either by keeping stock or by the application of manures, the land has never been allowed to go out of cultivation.

Another cause of land becoming derelict has been the cutting down of forests. This has been done over great areas, without any thought being given to replanting, and the trouble has been accentuated by numerous forest fires. Stretches of barren land are the result, and in many places this land is getting into a condition such that it will be very difficult to replant successfully. The cutting down of the trees has also affected the climate and rainfall, and had an indirect influence on agricultural land in adjoining areas.

In other parts, there are swamps which, like the fenlands of England, only require draining to make them exceedingly fertile. Before the draining of the fens by Cornelius Vermuyden, what is now one of the richest agricultural areas in East Anglia was largely an impassable swamp. The writer has seen a much more recent instance of this in the Western Peninsula of Ontario. By means of open drainage ditches and pumping stations, a worthless stretch of country near Lake Erie has been converted into good agricultural land. In this particular district, one pumping station served about 5000 acres, and the drainage cost to the farmer was from two to three dollars per acre.

In certain cases, too, land which does not at first sight appear to be of great value, is found from natural conditions or by artificial aids such as irrigation to be particularly suitable for the growing of some special crop. Instances of this may be seen in the Niagara fruit belt and the fruit growing regions of the Okanagan Valley of British Columbia. The Niagara fruit belt owes something to its soil, but it is not soil alone that has made it what it is, viz., a continuous orchard stretching from Hamilton to Niagara Falls, a distance of about forty miles. Probably the most powerful factors in this case are aspect and climate. It slopes gently towards Lake Ontario, and behind it is a steep escarpment which acts as a magnificent natural shelter. In the Okanagan Valley the great difficulty in many parts is the water supply, which is supplemented by schemes of irrigation.

Besides the best and most profitable utilisation of the land, there is industrial development to be considered. Many regions which are poor from an agricultural point of view, owe prosperity to other resources or to industrial progress, and the development of such resources, important even in this older, more exploited country, is doubly important in America.

Considerations along these lines led to the establishment of the Land Economic Survey of the State of Michigan, of which very interesting accounts have been published by its director, Dr R. A. Smith,[1] and the chief of the soils division, Mr L. R. Schoenmann.[2] Although the greater part of Michigan is in a prosperous condition both as regards agriculture and industries, it has many undeveloped natural resources. There is a very large area of land estimated at 12,000,000 acres, or approximately a third of the State, which is falling into a more or less barren condition. Much of this land was originally covered with forest, but with the trees cut down, it is now more a burden than an asset to the State. Attempts have been made from time to time to farm this land, but usually without success. In many places the soil is thin and sandy, and, although it is frequently eulogised by unscrupulous land agents, much of it is unsuitable for agriculture.

It was felt that something should be done in the way of examining these undeveloped resources, with a view to formulating some constructive policy and advising future settlers. After some difficulty a bill was passed in 1917 by the State Legislature, creating a soil and economic survey, but the circumstances of the time prevented its being carried into effect, and, for one reason or another, it is still in abeyance. Recently, however, certain public departments and institutions decided to co-operate and try the experiment for themselves.

General Organisation and Scope of the Survey.—The co-operating bodies were the State Department of Agriculture, the State Department of Conservation, the University of Michigan, Michigan Agricultural College, the United States Geological Survey, the United States Bureau of Plant Industry, the United States Bureau of Fisheries and the United States Weather Bureau. Each contributed men or money, or both, and the University, the Agricultural College and the United States Bureau of Plant Industry also contributed laboratory space and assistance.

Co-operation was entirely voluntary, but things worked very harmoniously. The general supervisory control of the work was exercised by the Bureau of Agricultural Development of the State Department of Agriculture, and the direction of the operations was given to the State geologist. To facilitate co-operation and to assist in the planning and organisation an advisory committee was appointed, consisting of two members from each of the State

[1] Address to the Michigan Academy of Science.

[2] Address to the Third Annual Conference of the American Association of Soil Survey Workers.

departments or institutions and one from the United States Geological Survey.

The scope of the survey is very wide. Perhaps its primary object is to obtain information as to the nature of the soil and other factors influencing agriculture and forestry. It also set itself to collect information on a wide variety of other subjects such as mineral and peat deposits; fish, game, wild life and plant resources; surface and underground water resources; holiday and recreation resources; possibilities of industrial development; and the economic factors which have influenced or controlled development in the past and seem likely to affect it in the future.

Surveys on individual subjects have previously been carried out in Michigan and in other parts of America, but nothing so detailed as this has previously been attempted. On that account and on account of the extensive co-operation, it has attracted a great deal of attention from other States, especially from those which have land problems. It is felt that such a co-operation of workers in different branches of science and from different institutions will give them greater breadth of outlook, and will lead to more practical results being obtained and more use being made of the results once they are obtained than would otherwise be the case.

Details of Working.—The workers engaged in the Michigan survey may be divided into three groups—

(*a*) Soil Surveyors. (*b*) Foresters. (*c*) Special Workers.

The systematic surveying and mapping is carried out by the soil and forestry men, who work in pairs, each pair consisting of a soil surveyor and a forester. Each prepares a field map: that prepared by the soil surveyor shows the various classes of soils and their distribution, and that prepared by the forester shows surface conditions. In addition to their maps the soil surveyors and foresters fill up a "Tally Sheet" with a great deal of data, principally on agriculture and forestry which is not easy to map.

The special workers join the surveying parties, or work separately as occasion demands. A certain amount of their data is collected by the soil and forestry workers, and they depend to a considerable extent on these men to bring to their notice special problems requiring attention.

It is interesting to note that after working for two seasons on the above system it is proposed that in future the soil surveyors and foresters should work separately. Something will no doubt be lost by breaking the close co-operation of these two classes of workers, but it was found that the forester covers the ground very much more quickly than the soil surveyor. It has also been found advantageous for the special workers, such as the biologists, to cover the ground a season later than the surveyors. This allows them opportunity to study the data and results obtained for them in the "Tally Sheets."

Soil sampling is carried out by means of the soil auger, and classification of the soil into types is done by inspection in the field in the manner commonly followed in America. The chemical analyses of representative soil samples are carried out by the Michigan Agricultural Experiment Station.

From the field maps and "Tally Sheets" of the soil and forestry surveyors, supplemented by data collected and worked out by the special investigators, further maps and comprehensive reports are prepared for the use of the State Departments, Colleges and other bodies engaged in the development of the State's resources.

As the aspect of the survey which is of most interest to us in this country is the relation of the soil to agriculture and forestry, it will be useful to examine in some detail the classifications employed by the soil surveyors in their soil maps and the foresters in their condition maps.

The Soil Map.—On the soil map is shown the mineral resources, the soil and surface classification, and such of the cultural features as are considered necessary to assist in mapping the soils and surface features.

The surface classification is as follows :—

1. Level land.
2. Undulating land.
3. Slight slopes on terraces.
4. Slight slopes on upland.
5. Moderate slopes on upland,
6. Steep slopes.
7. Hilly, rough and broken areas.
8. Eroded spots on any slope.

The soil units or types are grouped according to their textural or other dominant characteristics as follows :—

1. Gravelly soils.
2. Sandy soils.
3. Sandy loams and loams.
4. Silt loams and clay loams.
5. Clays.
6. Marsh border soils.
7. Muck and peat.

The soil types are to be shown on the published maps in different colours, and the surface classification by a system of cross hachuring.

Although the information given in the above classifications is of considerable value, it is obvious that unless other factors are taken into account it might be very misleading. Soils derived from entirely different kinds of rocks, and with quite different properties might appear together. Even soils from the same kind of material may differ greatly in behaviour if they have been formed by different natural agencies, and these differences would not be indicated on the map. It is, therefore, very necessary to give some information about the origin and history of a soil before any idea can be arrived at as to its behaviour, and even then other factors such as aspect, drainage and rainfall must be considered.

The origin and history of the soils are indicated in this survey by means of symbols in the following manner:—

Origin.	Division.	Symbol	Physiographic Group.
Residual	...	R	Upland
Aeolian . . .	Dunes	D	
Glacial	Morainic till	M	
	Morainic border	MB	
	Till plain	TP	
Fluvio-Glacial . . .	Kame	K	
	Esker	E	
	Outwash	O	
Lacustrine and Littoral .	Lake shore	S	Terrace
	Lake bed	L	
Colluvial and Alluvial .	Valley fill	F	
	Stream terrace	T	
	Stream bottom	A	
Cumulose . . .	Marsh border	B	Lowland
	Muck	Mu	
	Peat	P	

The following code is used in conjunction with the above symbols to indicate the character of the rocks from which the soil is derived.

Crystalline ‡	Shale =
Limestone *	Sandstone /

Thus a residual soil R, may have been derived from limestone R*, and in texture may be silt R * Si. A sandy loam, derived from Morainic drift of crystalline origin, would be M ‡ Sl. By an extension of this system the nature of the subsoil can also be indicated.

Peat has received a great deal of attention in this survey, and the special investigation work in this connection is under the direction of Dr Dachnowski of the United States Bureau of Plant Industry. On the soil map the following peat classification is employed:—

Origin.	*Character.*
Forest Peat	Woody
Sedge Peat	Fibrous
Aquatic Peat	Macerated Colloidal
Moss Peat	...
Heath Peat	...

By means of symbols, the map shows the origin, character and depth of the peat, and the nature of the mineral subsoil.

Where peat deposits of any considerable extent occur, and the depth is over 42 inches, samples are taken by means of a special auger and a form filled in with the following information:—

Field Conditions.	Soil Profile Description.	Profile.
Water Table (Extremes) .		
Water Test :		
Surface . . .		
Ditch		
Wells and Seepage .		
Contamination . .		
Mineral Subsoil . .		
Vegetation . . .		
Drainage System - Water Supply . . .		
Topography and Elevation		
Geology of Region .		
Soils of Region . .		
Industrial Record . .		
Crop Record . .		

The Condition Map.— The map made by the Foresters, termed the Condition Map, is the base map for those which are to be published. It shows roads, houses, water supplies, and what are termed cultural features. The most interesting feature of the condition map, however, is the following land utilisation classification which is shown by means of colours:—

A. *Improved farm land*—
1. Crop land.
2. Permanent pasture.
3. Orchards.
4. Used stump land.

B. *Idle land*—
1. Abandoned farm land.
2. Unused brush land.
3. Unused stump land.
4. Pin cherry and aspen areas.
5. Recent cutover and slashing.
6. Recent burns.
7. Beach and bare dune areas.

C. *Upland timber areas*—
1. Non-merchantable second growth.
2. Merchantable second growth.
3. Virgin timber.

D. *All timbered swamp lands.*

E. *Open grass and sedge and brush swamps.*

The Condition Map contains also the following classification

of surface vegetation on the peat and muck deposits. It is shown on the map by means of colours and symbols:—

1. *Swamp*—
   - D Maple, ash and elm type.
   - C Tamarack, cedar and balsam type.
   - Sh Willow, alder, aspen and dogwood type.

2. *Bog*—
   - S–C Sphagnum and cranberry type.
   - H Labrador tea, pale laurel, leather-leaf, blueberry—heath type.

3. *Marsh*—
   - R Reeds and canes—reed type.
   - B Blue joint, W Wire gass, S Saw grass—marsh type.

4. *Aquatic*—
   All shallow lakes and ponds with a soft muddy bottom of mucky material.

Progress of the Survey.—The field work of the survey was commenced in June 1922, and during the first season considerable progress was made in spite of the fact that many of the workers were inexperienced. During 1923, with practically the same staff, double the area was covered and the cost reduced from 8 cents. per acre to between 4 and 5 cents., a figure which it is expected to reduce still further. Some difficulty has been experienced in getting a sufficient number of suitable workers and retaining their services year after year. Only a few are full-time workers, and the remainder are drawn chiefly from the staffs and senior students of the colleges, who are only available during the vacations. Good progress, however, is being made with the work, and a great deal of valuable experience has been obtained.

Although a scheme of this kind is primarily intended for a new country, it has a certain amount of interest for us as well. The area of waste land in Scotland is, in proportion, considerably greater than that in Michigan. In any attempt to utilise such land, it is necessary to investigate the causes of its barrenness, and before this can be done the waste land must be classified. Experiments can then be carried out on the various classes.

The attention given to the study of peat in the Michigan survey has also a special interest for us, in view of our large areas of peat.

Not the least interesting feature of the survey is the element of co-operation. It has been recognised that a concerted attack on the problem of waste land by public bodies and institutions may yield results, which the attention of these bodies acting individually has failed to give in the past.

In conclusion, I desire to express my indebtedness to Dr R. A. Smith, the director, and Mr L. R. Schoenmann, the chief of the soils division, for information regarding the survey.

THE FLORAL PARTS OF THE POTATO AS AIDS IN THE IDENTIFICATION OF VARIETIES.

IN the identification of varieties of the potato, many botanical features have to be taken into consideration and of these the flowers and fruit are of great importance. In this paper, therefore, the floral parts will be discussed from the standpoints of differences in structure and in the physiological processes connected with their development.

There may be a widespread impression that the flowering of cultivated potatoes is not general, but it should be recorded that, with one exception, all potato plants, which have been examined during the various phases of growth, have developed flowers or at least produced rudimentary flower-buds. The exception occurs in the case of true "wildings," on which up to the present no floral parts have been observed.[1]

A. **Morphology of the Flowers and Fruit.**—(a) *Peduncles and Pedicels.* (*Inflorescence and Flower Stalks*).—Potato flowers occur in cymose inflorescences (*c.f.* fig.). The peduncles and pedicels vary in length and colouring with the variety, *e.g.*, in Up-to-Date and British Queen they are long and fairly dark coloured, while in Royal Kidney and Arran Chief they are short and lighter in colour. There is a tendency on the part of some varieties to form leafy bracts on the inflorescence stalks, *e.g.*, Lord Rosebery, Marvel, Dominion, Millar's Beauty, etc. Often, owing to a proliferation of buds, the whole floral structure is malformed and confused, a characteristic which is specially common in Findlay's varieties, Katie Glover and Celt. The density and distribution of hairs on the inflorescence stalks are also features of great importance in differentiating varieties, *e.g.*, in Kerr's Pink the hairs are numerous and adpressed, while in Reading Russet and the red-tubered variety substituted for Kerr's Pink the hairs are few and upstanding. Quite visible on the upper half of the pedicels is a distinct ring of corky tissue which indicates the point from which the flower or fruit falls. The varying position of this ring would seem to rule it out as a useful identification mark.

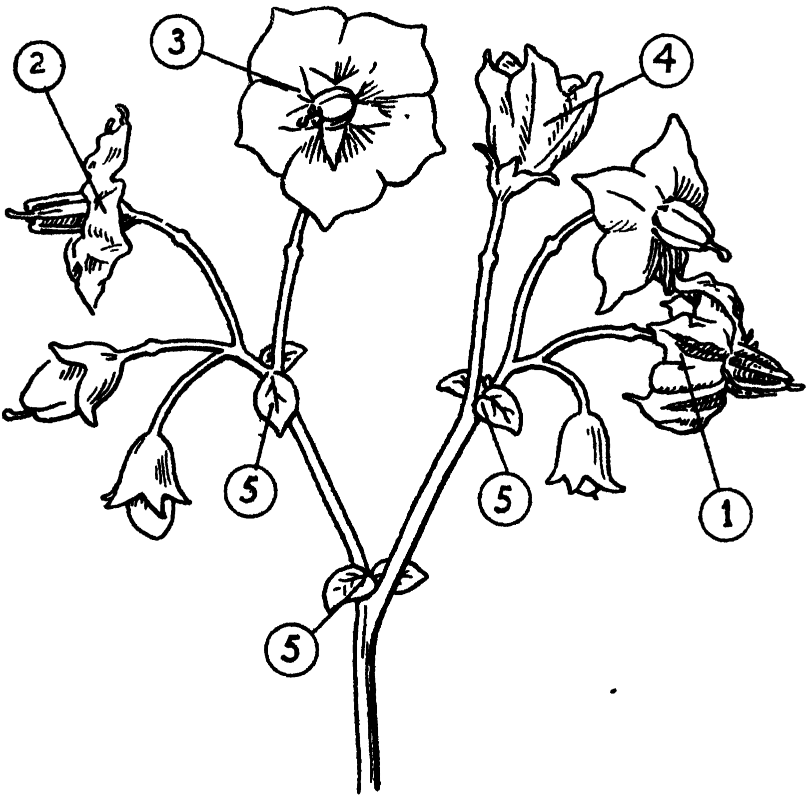
(b) *Calyx.* (*Sepals*).—The calyx is inferior. There are five sepals united at the base, their tips remaining free. Irregularity in number of sepals appears in some varieties, *e.g.*, in May Queen. Sepals may be uniformly coloured, as in Fortyfold and Rocks, where they are green, and in Di Vernon and Myatt's Ashleaf, where they are brownish purple. Frequently, however, the basal portion is green and the tips brownish, *e.g.*, Golden Wonder, Royal Kidney, etc. The reverse condition occurs in such varieties as Ninetyfold, K. of K., etc. A characteristic of great diagnostic value is the length of the sepal tips. The majority of varieties

[1] An exception to this rule is stated to have occurred in the case of "Arran Chief," in which a "wilding" with flower buds was reported in 1923.

have short tips, hence the long tips of Witchhill, K. of K., Arran Victory, etc., are useful for identifying these varieties. All sepals are hairy on the outer surfaces and the condition of these hairs is often useful for identification purposes. They may be long or short, numerous or few, adpressed or outstanding. In the variety Kepplestone Kidney, the hairs are infrequent and lie closely on to the sepals. On the other hand, in the variety Utility, the hairs are long, numerous and spread out.

(c) *Corolla.* (*Petals*).—The corolla consists of five united petals, and shows normally five tips. A departure from five has been observed in May Queen, Yam, Balmoral Castle, etc., in which up to ten tips have been counted. The size of the flower may vary on an individual plant, but some varieties, such as British Queen, may be described as large-flowered, while others, such as Dean and Rhoderick Dhu, are small-flowered. The size of the flower varies from $\frac{3}{4}$ inch to $1\frac{5}{8}$ inches in diameter. The petals are not so completely united in some varieties as in others, with the result that the flower may assume a star-like appearance, *e.g.*, occasionally in Northern Star. Fine hairs occur on the undersurface of the petal tips and extend downwards along the ribs referred to below. The frequency of these hairs seems to be characteristic of the variety. In the centre of the flower, and extending almost to the petal tips, are located five or more yellow-green rays or ribs consisting mainly of vascular bundles, and in some varieties this tissue becomes prominent by its purple colour. The colour of the flower is of value in identification, because it is almost constant for each variety. The petals can be self-coloured or parti-coloured. Potato flowers may be white, greenish white or purple. Purple, the predominating colour, might be regarded as being due to the presence of a red and blue cell sap, and, according to the proportions, the tint may be more blue or more red. The different coloured saps may exist in separate cells, but the possibility must not be lost sight of that only one kind of sap may be present, which varies from blue to red according to alkalinity or acidity. Pure red and pure blue do not occur. The colouring may vary in shade and tone on the different parts of the same flower; the tissue adjacent to the vascular bundles in the centre of the flower is usually deeper coloured than the remainder and red frequently enters more into its composition. The outer part of the petals lying between the tips is also frequently deep coloured. Generally, coloured flowers have white tips, but in some varieties, *e.g.*, Up-to-Date, this characteristic is absent. With age the colour of the flower fades, but within a variety the changes are uniform; the red seems to fade more rapidly than the blue, with the result that slightly withered purple flowers may actually appear blue. Varieties are sometimes coloured only on the lower surfaces of the petals, *e.g.*, Shamrock, Flourball, Dean and occasionally Majestic. It is impossible to describe in words the various shades and tones which appear in a flower. The most convenient method of arriving at a satisfactory standard is by using a colour-chart. The

comparison is made with the colour of the petals—but not the heart of the flower—when full maturity is reached, *i.e.*, when the petals are not reflexed, when the stigma is receptive and the anthers open at their tips. A definite correlation appears to exist between the flower colours and those of the sprouts of the tuber. Varieties with pink sprouts show the colour as red purple in the flower, or they may be white; blue sprouts are followed by blue or blue purple flowers, or white. The white flowers may be regarded



POTATO INFLORESCENCE.

1. Young Flower.—Note reflexed Petals. 2. and 3. Flower at Full Maturity.—Petals not reflexed. 4. Old Flower.—Petals no longer open. 5. Leafy Bracts.

as albinos, with the colour element absent and occur in both groups. The significance of this correlation lies in the fact that it enables one to state very frequently to which of the two principal groups in the potato classification the plant in question belongs. Where the flower is white, other indications, such as colour on stolons (*i.e.*, runners), tuber, etc., are utilised for this purpose. While the flower colour is an extremely useful identification mark, it must not be regarded as infallible: the potato not infrequently sports with regard to this character. Thus, white flowers have been found in the following varieties:—Up-to-Date, Field Marshall, President and Golden Wonder. Occasionally an inflorescence is

met with in which white and coloured flowers exist together, *e.g.*, in Field Marshall; and very rarely individual coloured flowers may have a white sector, *e.g.*, Golden Wonder. Again, "General," a white flowering variety, occasionally produces red-purple flowers.

(d) *The Androecium.* (*Stamens*).—There are five stamens. Each anther lobe consists of two pollen sacs which open by means of a single pore situated at the apex. The stamens are normally arranged in a symmetrical column surrounding the pistil, but in most old flowers, *e.g.*, Kerr's Pink, Abundance, Crusader, etc., they assume a loose appearance. Some varieties, however, such as the Rogue No. 38 (1923),[1] are characterised by loose but normal stamens, in the younger flowers. Other varieties appear incapable of forming normal stamens, these generally remaining small, yellowish and twisted, *e.g.*, King Edward, Ally, Arran Chief, etc. The normal colour of anthers is orange-yellow. Yellow or greenish-yellow anthers are found in some varieties and in others at times a reddish tinge is exhibited, *e.g.*, Rector. Stamens sometimes become pistillate in character, forming a rudimentary ovary with ovules and stigmatic surface surmounting, but as yet no ripe seeds have been found or induced in these, *e.g.*, Champion, Celt, etc. The colour of the anther is in general a varietal characteristic, but exceptional plants occur commonly in many varieties in which a departure from the normal is found.

(e) *Gynacium.*—The Gynacium is superior, consisting of two united carpels.

(1) *The Stigma* generally projects about 2 to 3 mm. above the apices of the stamens; it is usually bilobed, but not infrequently 3 to 4 lobes occur, *e.g.*, in the variety, East Neuk. The stigma is green and at maturity a sticky fluid is exuded on its surface. The stigma is usually receptive before the anthers open.

(2) *The Style* is generally erect and light green coloured; in some varieties, however, it may be twisted, *e.g.*, King Edward, while in at least one variety—Buchan Beauty—it has a characteristically purple coloured ring at a point almost coincident with the apices of the stamens.

(3) *The Ovary* includes two cavities and the numerous ovules are arranged in what is known as axile placentation. Multilocular ovaries occur, but these are not characteristic of any definite variety.

(f) *The Fruit.*—The potato "plum," "seed ball" or "apple" is a berry. The round form of the fruit is stated to differentiate *Solanum tuberosum* (*i.e.*, the common potato) from some wild tuber-bearing species of the same genus, e.g., *S. commersonii* and *S. demissum*, whose plums are heart shaped. At least one cultivated variety, the "Ham Red" of Orkney, exhibits the heart shape form of berry. Such plums have also been found on seedling varieties. *e.g.*, Ceres Beauty. The size of the fruit varies on an individual plant, but varieties may be grouped into those

[1] *See* Board of Agriculture for Scotland: "Key to Potato Trials and Reference Collections, 1923."

which produce large and those which produce small fruit normally. The size, however, may depend on capacity for receiving pollen, *e.g.*, one can induce large berries on varieties which produce normally small-sized fruit by using profusion of pollen. Green is the usual colour of the plum, but different varieties exhibit different shades of green. Some varieties show red or brown markings on the skin and some are purple, *e.g.*, Kepplestone Kidney. Purple plums have so far only been found associated with blue sprouts. When the fruit has been stored for some time generally a light buff colour is developed. The placenta (*i.e.*, the tissue from which the seeds arise) of some varieties is coloured, a characteristic which is of considerable importance for identification purposes. As yet, the colouring has only been observed in varieties the skin of whose tubers is coloured. The colour varies from almost a pure pink to a dark purple. Some varieties have the colouring only in the young fruit, *e.g.*, Shamrock and Flourball, and in others only the mature fruits are coloured. The placentas of Edzell Blue, Orkney Blue, Old Long Blue, etc., are deep purple; those of Lord Rosebery, Ranfurly Red, Cardinal and Prizetaker are pink or reddish purple; while some varieties with coloured tubers exhibit no colour, *e.g.*, Pride of Bute, Rector, Tawny, Reading Russet, etc. If the calyx be removed from the fruit, normally a buff or yellow coloured ring can be seen at the point of attachment. In at least one commercial variety—Rector—this ring is red, and in others it is purple. Up to the present, the purple colouring has only been found on seedlings, but there is no reason to assume that it will not at some future date appear on a commercial variety. Its occurrence appears to be associated with blue sprouts. As further varietal characters peculiar to the fruit the following deserve mention:—(1) the ease or otherwise with which the plums separate themselves from the mother plant; the fruit of Flourball, Majestic, etc., falls easily from the inflorescence stalks while that of Leinster Wonder or of Keppleston Kidney clings with some tenacity to the parent; (2) the aroma; such fruit as Majestic is seldom, if ever, scented, while that of some varieties, *e.g.*, Myatt's Ashleaf, when fully mature, emits a pleasant odour; (3) some varieties at times form natural berries which are devoid of seed, *e.g.*, Arran Comrade.

B. **The Physiology of the Flowers and Fruit.**—(a) *Flower.*—The opening of the flower bud takes place at the apex and seems to be occasioned by the increasing growth and pressure of the enclosed floral parts. Normally, the petals are the first structures to appear when the buds open, but owing to different relative developments in some varieties, *e.g.*, Rector, Catriona, Pepo, etc., the stamens and pistil are usually visible before the petals. The colour of the petals commences to develop whenever the bud opens; in the closed bud they are greenish. One day or perhaps two days after the bud has opened the petals are fully developed and in most varieties are reflexed. On some, however, such as Northern Star, Rhoderick Dhu, Arran Chief, Duke of York, this characteristic has not been observed. At this stage the anthers

have developed their deepest colour and occasionally show browning at the tips. The stigma is now sticky. Full maturity of the flower is indicated when the petals lose their reflexed character, when the anthers are open and the stigma receptive. The pore at the apex of the stamens is at first round but ultimately becomes oval, when the walls are deep brown in colour, with a white margin. The condition of full maturity may be maintained for several days. Ultimately, the flower begins to fade and a brownish colouring appears on the petals, which lose their elasticity and do not open completely; finally, they remain closed. The anthers become browner and shrivelled and a longitudinal slit usually appears on the inner side of each lobe. As the flower grows older, the stigma loses its glistening appearance. The flowers fall off along with their upper short flower-stalks. Sometimes, however, the corolla and stamens fall off first; at other times the corolla remains attached to the growing fruit for a period after the stigma and style have been thrown off.

The duration of the flowering period is peculiar to the variety. Data have been collected for several varieties and it appears from observations made in Edinburgh during 1923 that individual plants may flower from four to eight weeks; individual inflorescences from two to three weeks; and individual flowers from six to fourteen days. Characteristic, however, as differences between varieties in these directions may be, variations in the daily blooming period form a more useful means of identification.

The Daily Blooming Period.—A marked difference exists in the sensitiveness of the flowers of various varieties to outside influences. Young flowers are naturally more sensitive than older ones. Some varieties, *e.g.*, Templar, open early in the day; and others, *e.g.*, Northern Star, Duke of York, open only in full sunshine. There is not much difference in the times of opening and closing of flowers of one variety in a particular locality. Temperature does not appear to exert such an influence over the opening, etc., of flowers as does moisture. Some varieties, *e.g.*, Arran Comrade, Up-to-Date, British Queen, etc., are very sensitive to the influence of moisture; others, *e.g.*, Champion and Crusader, are not so readily affected. The normal period of closing in the afternoon also varies with the variety. The flowers of Templar, Champion, etc., remain open to a later hour than those of Arran Comrade, British Queen, etc.

Pollen.—The pollen grains, which are generally round to elliptical in form, retain their capacity for germination for several days. In one variety they remained potent for six days in stamens which had been removed from the flower. The amount and viability of pollen seems to be a varietal characteristic.

Although self-pollination is normal in this country, the potato flower seems to be adapted to insect visits: indeed, it is recorded that some varieties are at times odoriferous, *e.g.*, Templar.

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(b) *The Capacity for Flower and Fruit Formation.*—Varieties differ in their natural tendency to flower and fruit. Thus, the following varieties flower and plum freely—Templar and Majestic; others, *e.g.*, British Queen and Up-to-Date, flower very freely, but do not form fruit naturally; others again flower very seldom and have not been known to bear natural berries, *e.g.*, Great Scot, King Edward, Arran Chief, Northern Star. The formation of flowers is essentially constitutional for the variety. Breeding and artificial selection have resulted in many practically non-flowering varieties being put on the market. The production of fruit in flowering varieties would appear to depend almost entirely on the formation of fertile pollen, as even such varieties as King Edward, Arran Chief, and Up-to-Date plum when viable pollen is used. During 1923 nine flowers of Up-to-Date, fertilised with pollen of the variety Pepo, all produced normal berries. In seeking "rogues" in a field caution must be exercised in judging whether a plant is a "rogue" or not, especially when the only difference discernible lies in the profusion of flowers; accidents, *e.g.*, injury to the stem by animals, implements or disease may induce a profuse setting of flowers and in all cases the presence or absence of such exciting causes should be looked for. "Bolters," because of their increased capacity for flower and fruit bearing, may also be mistaken for "rogues." To obviate such errors, those engaged in purifying stocks should familiarise themselves with the other characteristics of the "bolter" type peculiar to the variety in question.

(c) *Environmental Influences on Flower Formation.*—As the production of flowers can be influenced to a very great extent by environment, a word or two on this subject is not out of place. There appears to be a certain optimum condition of soil and atmospheric moisture, of warmth and of light, which is most favourable to the production of flowers: low temperature, too much moisture and too little light appear to be unfavourable, while warmth and plenty sunshine seem to encourage flower formation. According to one authority, where the overground food supply (CO_2) exceeds the corresponding neutralising underground mineral supply through the roots, the plant is forced to develop organs which can consume carbon quickly, *e.g.*, flowers—a theory which finds support in the fact that, when stems are partially severed, the production of flowers is greater than normal. Despite theoretical considerations, however, the fact remains that a variety may flower freely one year and show comparatively few flowers the next. Cultural conditions also, *e.g.*, hard ground, may increase the tendency to flower.

In conclusion, it should be pointed out that in comparing and identifying varieties, it is injudicious to place too much importance on any individual floral character; the plants as a whole must be considered and differences in the flower parts must always be studied in conjunction with the remainder of the organisms.

THE following notes on the making and use of silage in the Highlands, with particular reference to Argyllshire, have been contributed by Mr A. P. MacDougall:—One of the greatest deterrents to a more intensive system of pastoral farming in Scotland, especially in the Highlands, is the excessive rainfall, owing to which the harvesting of both hay and grain is an uncertain and costly business. As a result the grazing of hill lands has in many cases become lopsided, and sheep have ousted cattle to the permanent injury both of the sheep and of the pastures. A further result has been the deplorable overstocking with sheep of many of our Highland farms, which in its turn has led to the reversion of so much land to the most primitive of all uses—the grazing of deer. Of even greater moment has been the consequent reduction of labour to a minimum over an area comprising millions of acres. Fifty years ago labour in these districts was plentiful and cheap, and the task of securing winter fodder for cattle was not difficult. To-day labour charges, excepting where machinery can be utilised to the fullest extent, have made this work almost prohibitive in cost. On the class of grazing to which I refer the annual increase in the weight of cattle is small as compared with that on richer pastures, hence, as the capital turnover is smaller, there is all the greater need for the effecting of drastic economies.

Silage.

For many years this ever-increasing problem has received the closest attention from keen and progressive farmers and research students. Their greatest efforts gave, at first, little room for encouragement, and it is only within the last few years that a possible road to success seems to have been opened up—I refer to the use of silage.

My attention was first drawn to this form of fodder as a practical proposition by Principal Paterson during the early years of the war. He described to me the marked success which had resulted from an experiment carried out by the West of Scotland Agricultural College on an estate near Lanark. Rough grass mown from roadsides and plantations had been made into ordinary stack silage. The analysis showed a high feeding value, and in practice the material, otherwise almost useless, proved both palatable and nutritious. On that occasion I discussed with the Principal the possibility of converting bracken into silage, and shortly after, I had an experimental stack made. During the winter months I had the stack cut into and a load taken out for trial. It was offered to a lot of store cattle which had been well fed, and they refused it. Only one attempt was made to get them to eat it. From my recollection of the material and in the light of future experience, I am inclined to think that with a little more coaxing the cattle might have eaten it greedily. I know now that even the most palatable silage is sometimes rejected by stock to start with. The bracken had the smell and the appearance of first-class silage, and the cattle nosed it as if it appeared to tempt them.

I had no further opportunity of going into the question until

Lord Astor asked me to carry out experiments in the wintering of cattle in Jura. This island was at one time famed for its three- and four-year-old Blackfaced and Cheviot wethers and also for Highland cattle. For many years, however, the lands of Ardlussa and Tarbet have been almost entirely given over to deer. When Lord Astor purchased this property almost four years ago he determined to restock with sheep and cattle. On part of the estate the land produces a luxuriant growth of grasses suitable for cattle, several hundreds of which can be grazed during the summer months without hurt to either deer or sheep. On the contrary, this rank herbage if not eaten down becomes useless to both classes. It would be safe to say that before the land was burned and more closely grazed thousands of the most fertile acres provided no sustenance even for deer. Summer grazing on such land is and always has been of an extremely speculative nature, and this applies especially to an island where the transport of cattle is difficult and somewhat costly. From an economic point of view, the whole question turns on the provision of suitable and reasonably cheap winter fodder.

On the estate of North Jura there is for all practical purposes no arable land on which to produce winter keep. An almost unlimited amount of rough hill hay can, however, be cut, and was cut in former times. To-day, as I have already pointed out, in an uncertain climate, the cost of haymaking on such land is prohibitive. Lord Astor, who had had experience of silage making on his English estate, suggested that it might be tried in Jura. The first test was made with a small stave silo, which was filled with rough herbage. The result was entirely satisfactory, even though, owing to delay in erection, the material used had become too fibrous and dry. A bunch of about thirty Highland cattle, outwintered of course, were brought through the winter on the silage, and were maintained in excellent condition. They were fed once a day.

The following year it was decided to experiment with stack-made silage and compare the two methods. The result has been so satisfactory that it is not intended to erect any more silos. One great advantage of the stack over the silo is the saving of considerable capital expenditure. A further advantage of equal consequence is the reduced cartage required in making a stack on any suitable spot adjacent to the land producing the material, as compared with carting or sledging on rough ground considerable distances to the silo. There is still another advantage. Cattle can be fed in small lots attached to each stack. They waste no time in coming or going from their grazing ground when the silage feed is finished. After a short period of rest they begin again to forage for themselves. It is with outwintering cattle, as it is with sheep, a serious error in management to allow them to waste time cowering at dyke backs. These animals are like men. They can withstand astonishingly severe weather if ample fuel in the shape of provender is at hand to keep their internal fires

burning. Cold on the lower altitudes of Great Britain never kills cattle—starvation does.

Even if the silage has to be carted to stock at a considerable distance from the place where it is made, it would still, to my thinking, be an advantage to make it as near the point of production as possible. The mid-summer and autumn months are always the busiest on the farms to which I refer, as they are on all farms, and long cartages of heavy material would prove troublesome, if not well-nigh impossible, just then. Not only is there more time in winter for carting the silage as required for stock, but the bulk and the weight are very much less than in the case of the newly mown grass.

In silage making the farmer is entirely independent of weather conditions. He need not grudge good days spent in clipping or at the various handlings of sheep. His workers can be employed to as much profit in a wet period as in fine weather. The irritation and annoyance incidental to haymaking disappear, and harvesting becomes a matter of routine. The process is comparatively simple. The most suitable and convenient spot is selected for the stack. Mowing, carting and building can be proceeded with at the same time, or if the staff is insufficient, mowing can be done in the morning and the material stacked in the afternoon. If the weather is damp or wet, then the staff can be kept mowing for a whole day and carting can be undertaken the day after.

The stack should be kept as solid as possible, in order to avoid waste and produce the best material. On sinking it should be added to, as the greater the bulk contained in one stack the less wastage there is. When the stack has been completed, it can be weighted either with stones or turf. Care should be taken to make it as rainproof as possible, and the centre should always be kept well hearted, as owing to the increased temperature there is greater shrinkage there than on the outside.

The ideal method for a stack silo can only be carried out on soil of a dry sandy nature which is rarely met with on hill land. Under these conditions a pit should be dug depending in size on the quantity of material available, filled up and when ground level is reached, the empty carts or sledges should be driven over the stack as further stuff is added until it finally assumes the appearance of the hog back east country dung heap. If this method is properly carried out the percentage of waste is negligible. Even with stack-made silage the waste can be reduced to a trifling amount. The best teacher is experience and intelligence to make practical use of it when it has been gained. Under favourable conditions it is wonderful how much hill land can be cut with a horse mower, but of course the greater part of the land to which I refer must be cut with the scythe. Where the ground is too rough for carts, light sledges with frames can be used to advantage.

I asked Mr M'Intyre, the farm manager on North Jura, to write me a few notes for the purpose of this paper. I will quote his letter:—

"When the weather was unsuitable for haymaking, I occupied

the time making silage. We have several stacks—one of 12 tons, 10 tons suitable for feed, the remainder waste. One could very much reduce the waste in the stack by another year, as I see by experience where it could be improved on. What is suitable for feed would cost about 1s. 3d. per cwt. including all labour costs, I estimate the cost on the 10 tons good stuff. Cross Highland heifers are fed on the above. They are getting 20 lbs. per day and have been since mid-December. They have put on condition and are extra well wintered, getting no food but the silage. Strong three year old bullocks are getting 25 lbs. and getting nothing else. My experience is that it is more suitable for out-wintering cattle than hay, and of as much, if not more, value. Both sheep and horses eat it all right, but I cannot say with what result, as I only tried it to see if they would eat it."

It would be difficult to conceive a cheaper fodder than is indicated by this statement, which shows that cross Highland two year old heifers are being wintered at a cost of approximately 6s. per month and that they are thriving on the allowance given them. I have heard it suggested that cattle do not summer well after silage, and that losses through death are apt to follow its use. Two years' experience in North Jura proves that there is no foundation whatever for this supposition. As a matter of fact, since no deaths have occurred with silage-fed animals, the contrary would seem to be proved. Silage has apparently the property of making palatable the most astonishingly rough material. Last year one plot of about two acres of exceptionally strong rushes was cut and stacked. The cattle ate them greedily. Another example of this remarkable property is known to the writer. A field of wheat had failed and the land being extremely foul, a luxuriant and very heavy growth of stinking camomile and thistles took the place of the wheat. To prevent seeding taking place the farmer cut this green and carted it into a large heap with the intention of letting it rot into dung. Instead it proved a most acceptable feed for calving cows.

It is not within the scope of this paper, but it may prove of interest if I state that the result of the policy which Lord Astor laid down, the burning—I may almost say the wholesale burning—of grass lands and heather and the grazing of cattle has been not only an almost entire diminution in the death rate in sheep—even recently imported sheep—but an increase in the average weight of stags on certain beats by no less than two stone. Owners of deer forests will be well aware of the difficulty in securing this increase. As Jura is an island, there can be no question of deer migrating elsewhere and thus receiving benefit from other pastures.

It is perhaps hardly necessary for me to say that in dealing with this subject I have refrained from dealing with the technical or scientific side of silage making. This side has already been frequently dealt with. It is written with the desire of stimulating the practical application of that research, and that it has practical

possibilities of tremendous import is proved beyond the shadow of doubt.

These notes are contributed by Captain D. J. Munro, C.M.G., R.N. (retired):—At Auchindoune, Cawdor, Nairn, where I live, I erected a wooden stave silo 13 feet in diameter by 30 feet high, on a base of old railway sleepers. The cost of this silo was about £180. The wood is red pine creosoted. The shoot goes direct into the barn, and the cutter and blower are worked from a belt on the barn shafting, which shaft is run by an 8 h.-p. water wheel, situated about 70 yards from the shaft, the power being conveyed by a wire rope. The actual power delivered at the cutter is about 6 h.-p.

Seven acres of a mixture consisting of 2 bushels tares, 1 bushel pease and 3 bushels oats was sown in April, with a dressing of farmyard manure in a field which would have been turnips in the ordinary rotation. Another two acres of the same mixture was sown in a field which was part of a field under oats after three years' grass; no manure. The first field, owing to the cold and dry spring, followed by a very indifferent summer, gave a poor crop of about 7 tons to the acre: the other field a better crop of about 8 tons to the acre. So altogether there was about 60 tons to harvest.

Owing to delay in getting the alterations made in the mill shaft to work the cutter, cutting was about two or three weeks late. Consequently, the corn was nearly ripe and the pease and tares in full pod. However, the carting and cutting were done successfully inside a week, and, as far as my knowledge goes, the operation was a success. One man was employed inside the silo tramping with a good deal of assistance, and, as the silo has no concrete or other base, a load of bracken was first cut and tramped in, and then, acting on Dr Tocher's advice, a load of straw was cut and blown in, and during the operation of filling a load of straw or hay was put in at about every six feet. This was to absorb the juices that would otherwise run to waste. The crop filled the silo to about six feet from the top, and, up to the time of using the silage, it had sunk another four feet.

Altogether there are on the farm feeding on silage:—

167 Cheviot ewe hoggs from my west coast sheep farm.
24 Stock ewes for breeding tups from.
10 Young tups.
2 Old tups.
3 Dairy cows.
2 Old cows fattening.
4 Breeding cows.
1 Bull.
3 Farm horses.
1 Pony.
6 Highland cows (outside).
8 Highland heifers (outside).
1 Stirk.

The silage is much the same as silage I have seen from other silos, having a sweet and pleasant odour of treacle or brown sugar. The old straw and hay interspersed in layers acquired this smell also. All the cattle in the stalls and fold took to it almost at once, so

did the horses. Sheep outside, as long as they could go picking about, would not go near the boxes, but as the weather got harder they soon took to it, especially when some bruised oats was mixed with it. The lambs were the hardest to acquire the taste, but as we did not want to put them on short commons, as they might go back, we left them with the boxes. putting a little fresh in every day, and they are now eating it readily. The ration supplied to the Highlanders was mixed with chaff, and they are fed outside. They readily took to the mixture, which is put in heaps in the field for them—one heap for each animal. Salt is mixed with the silage for all animals, as well as rock salt in the feeding boxes and troughs in the fold.

The silo, in my opinion, has been a great success. Even though the season was a bad one, crop not up to the mark, and cutting delayed, it has turned out to be just the thing. Another point which has come out is, that owing to the foot-and-mouth disease I did not care to get store cattle, and if I had only turnips, my turnips would have been wasted, but I could, if necessary, keep all the silage for another year or longer.

I have only one pig, and he eats it readily, but I do not intend to continue feeding him on silage, as owing to the delay in cutting there is, in my opinion, too much fibre in the ration. Silage for pig-feeding is excellent when the crop is cut very green, so that there is a minimum of fibre.

It is my intention to get the ewe hoggs well used to eating silage, so that when they are gimmers next year with their first lambs, I can give them a feed of silage to increase the milk supply and tide them over that trying time for young stock on the west coast, especially if it is a dry March. For the above reason, and also to ensure their having an even set of front teeth when their young teeth are coming, it is my intention to give them only silage and hay during the last of their stay here.

I consider that the two most important items that sheep can have on the west coast of Scotland are a strong constitution and an even set of front teeth. A ewe has to spend the greater part of the day securing enough food to keep herself and her lamb going, and if even one front tooth does not meet the other it makes it all the harder to secure enough to satisfy her wants. Biting at hard turnips is most certainly the worst possible manner to secure a set of good teeth in a hogg when the old teeth fall out.

The silo I erected at Glenmhor, Kishorn, Lochcarron, Ross-shire, is that called the "Homestead," 10 feet by 30 feet, octagonal in shape, which holds about 50 tons. This silo cost £75 complete. The foundation is just the ground. The wood is Scotch fir creosoted.

I sowed about five acres of tares, pease and oats on old pasture; no manure. The crop did fairly well, but would have been much better if the season had been a good one. As I have only one cutter for the two farms, and, as the crop of this farm was about three weeks ahead of that on the east coast, I was fully a month

late in cutting the crop. However, it was cut and tramped in, and enough meadow hay also cut and put in to fill the silo. Owing to a breakdown of the cutter, due to want of oil on a bearing, a second filling could not be done, as the hired tractor had to go to other work. Consequently, the silage when settled was about eight feet from the top. When this silo was opened up the silage was much drier than that on the east coast, except in the centre, but by mixing both together the result was satisfactory.

The stock on this farm which gets silage at present consists of the following :—

3 Milk cows.	6 Ewe hoggs.
4 Highland stirks.	1 Old mare.
14 Tups.	

They are all eating it readily.

To start them I placed the Highlanders in the fank for the night, and next day they were eating it with relish, and now they get a feed once a day, and they are always at the feeding place in plenty of time. The same procedure was adopted with the tups, etc. The only animal that does not take to it readily is the old mare. She will eat it, but only under protest. However, she is now taking to it better.

Judges of cattle who have watched my animals on both farms remark on their healthy look, especially their coats. What has been noticed more than anything else with the stock on my east coast farm is that animals fed on silage do not hang about listless and shivering as they do after a feed of half-frozen turnips, but skip about and are very lively and contented looking, with a very good coat of hair. I have one "piner" in the byre—a calf—that was never properly suckled by her mother. She is growing fast on silage and turnips, and promises to turn out all right.

In my opinion silage is suitable for all classes of farm animals. A greater stock can be kept in better condition than on turnips and at a third of the cost. On the west coast of Scotland the smallest croft should have a silo. Two tons of silage will see a west coast cow through the winter, and it is a very small croft that could not produce this quantity of silage.

Both silos that I have erected are moveable, especially the "Homestead," which was erected by two carpenters and a labourer in four days, and can be taken to pieces in one day—weight, three tons, five cwts.

Taking everything into consideration, a "Homestead" silo will pay for itself in the first year. Where a farmer has motive power equal to 6 h.-p., all he wants is the cutter, costing £60 upwards, according to size.

It is my intention, as already stated, to feed my hoggs on silage only, before they are moved to the west coast. By this method they will be accustomed to it, and during the rest of their stay on the west coast they will take to it at once if there is any occasion to feed them on it owing to a dry spring, hard weather or other causes. My object is to make certain that my breeding

stock will have a plentiful supply of milk, and if I have that, my lambs will be good. I am also going to feed about a dozen Highland cows and their followers on silage in the future on the west coast.

My advice to farmers is to cut their silage crop when it is green and sappy; don't fill the silo too quickly; tramp hard. Each morning before carting starts all hands should go into the silo for half-an-hour and tramp. Keep two men constantly in the silo (one a reliable man). Knock off half-an-hour before finishing time, then all hands into the silo and tramp hard, especially round the edges.

Contrary to the generally accepted opinion, silage tramped hard does not bear outwards on the silo walls. Silage contracts from the sides to the centre, and from the top to the bottom. The reason for this is that straw and all fibrous growths such as wood, etc., do not contract longitudinally. For instance, in a stack of straw the sheaves radiate outwards from the centre, and the stack in time will diminish in height but the diameter will remain the same. With silage the straw is cut up into short lengths and mixed, consequently contraction takes place all ways. An ideal silo would be conical in shape with the apex downwards, consequently it would have a greater diameter at the top and would contract into a smaller diameter.

Contrary to the generally accepted opinion that it is the juice from the compressed crop that is seen running from the bottom of the silo, it is my opinion that this is the moisture from the heated air condensed on the walls of the silo and then running down to the base, carrying some juice from the bottom with it. The same process takes place in a ship laden with grain and causes great damage if the cargo is not so stowed that the bags are protected against contact with the ship's side. This condensation is much greater in a concrete silo than a wooden one, as the concrete is much colder and does not absorb the moisture. Owing to the layers of straw and the straw base and bracken in my silos, no juice or water has run from either of them.

There are very conflicting reports as to the quantity of material a silo will contain, but this obviously depends upon the amount of tramping the contents receive. In any case I do not think that silage—unless it were very wet—would ever be heavier than coal, and that runs to about forty-five pounds per cubic foot. My silage is about 34 lbs. per cubic foot.

Pastures.

THE following notes on pastures, with special reference to recent investigations in Sweden, are contributed by Dan. W. Steuart, B.Sc. (Agric.) :—In earlier times pasture constituted practically the sole summer food of cattle, and the breeding animals were carried through the winter on scanty fare, consisting chiefly of meadow hay. Gradually a change took place, due largely to the extended cultivation of root crops,

whereby winter food became plentiful and varied. Now we find that cows which calve in the autumn may show greater milk yields than those calving in the spring. It is, nevertheless, still the case that *good* pasture is the cheapest and healthiest food for stock, specially for young growing cattle. The word "good" is emphasised because there are undoubtedly sour, unwholesome pastures where young stock do not thrive, and in such cases the trouble may arise from a deficiency of bone-forming minerals in the herbage. The beneficial effect of good pastures on young stock is partly due to the well-balanced nature of the diet, containing as it does a sufficiency of flesh-forming proteids, together with suitable bone-forming minerals, and also to the presence of the vitamines required to enable the young stock to retain and utilise the nutrients in the food.

The following facts gleaned from British sources indicate the need for paying greater attention to our permanent grasslands. The average yield of meat from British grassland is only about 70 lbs. per acre; whereas the best Midland fattening pastures produce 190 lbs. (Middleton). Land producing only 20 lbs. of lean meat at Cockle Park has been made to produce 105 lbs. by the use of basic slag. The average yield of hay from unmanured meadows at twenty centres in England was 23 cwts.; the manured plots averaged 34 cwts. per acre, the former figure being very near the average for the whole country (Stapleton). A Dumfries pasture on peat was treated with 10 cwts. slag and 8 cwts. kainit, which increased the yield of mutton sufficiently in the following seven years to show a profit (Somerville).

The yields of pastures, in fodder units per acre, permit the following classification:—

Excellent pastures	Over 3000
Very good pastures	2500 to 3000
Good pastures	2000 to 2500
Medium pastures , . . .	1000 to 2000
Poor sheep pastures . . .	100 to 600

Arable land in Scotland produces on the average about 2560 fodder units per acre, if we exclude the rotation grass, or including that, then about 2020. Timothy meadows produce some 1860, while hay from other permanent grass averages 1160 fodder units per acre. (It is interesting to note, as a matter of comparison, that according to official figures quoted in an article in the last number of this *Journal*,[1] the average production of all agricultural land in Denmark is now 2215 fodder units per acre, or about double what it was thirty years ago.)

Apart altogether from manurial treatment, however, it is possible to manage the grazing of pastures in such a way as to get increased yields. In the Scandinavian countries the advice given is to *graze early and frequently*, so as to encourage the formation of a dense sward of young juicy grass—to pasture off

[1] Page 83.

the fields five to six times during the grazing season at intervals of three or four weeks. An old Dutch saying advises us to put young stock to grass when it is 2 inches long, but cows when it is 4 inches long. Tillering of the plants is to be encouraged, and the production of flowering heads to be discouraged by every possible means. If patches are being neglected these may be sprinkled with salt to stimulate interest in them; and, as a last resort, they may be mown over and the cuttings fed in the shed or made into hay. Also the various classes of stock feed differently, and this fact should be utilised. At Cockle Park a pasture grazed with sheep and cattle together produced 200 lbs. of gain in live-weight per acre per annum; while grazed with sheep alone it produced only about 100 lbs. (Gilchrist). Speaking generally more harm is done by understocking than overstocking. . . . Intensive grassland cultivation is incompatible with large enclosures (Stapleton).

During the years 1915 and 1916 Professor Nils Hansson had 100 acres of pasture under test at Valinge, Sweden, and the chief object of this paper is to describe the methods he used in estimating the yields of the pastures (in fodder units), together with the results of some of his experiments described in Swedish Reports 136 and 151, and in the *Nordisk Jordbrugsforskning*, 1922.

Two methods of estimating the yield were employed (1) cutting and weighing the grass, and then determining its composition and food value; and (2) keeping records of the production by the grazing cattle.

I. The following average results were obtained, working by the first method in 1916:—

Date of Cutting.	*Cwts. Grass per Acre.*	*Percentage of Total Crop.*
23rd May	26·1	13·7
19th June	49·6	26·0
17th July	60·1	31·5
14th August	41·6	21·8
7th September	9·1	4·8
9th October	4·1	2·2
Total	190·6	100

It will be seen that cuttings were taken from enclosed plots every four weeks to imitate six successive grazings by stock. The greatest amount of fodder was produced in June, July and August, and corresponding to this the stock on the pasture made the greatest gains in live-weight from mid-June to mid-July. It is obvious that the pastures will carry fewer stock towards the autumn, and if the same number of cattle have to be grazed all the summer through, then use has to be made of aftermath from fields from which a crop of hay has been taken, or some other means of supplementing the pastures must be found at the "backend" of the grazing season.

The examination of the herbage of the plots showed that 20 per cent. consisted of leguminous plants; the average water content was 78 per cent.; organic matter constituted 20 per cent. of the weight, and 78 per cent. of the organic matter was digestible. It would require 5·5 lbs. of the fresh green grass to constitute a fodder unit, and the unit would contain ·12 to ·13 lbs. of digestible proteid. As the total weight of grass grown was 190·6 cwts., the yield in fodder units per acre would be 3880—this being based on the average of three plots on each of three pastures, each plot being about 100 square yards.

In order to measure the increased yield of grass due to various manurial treatments, plots were protected from stock on the 23rd of June (1916) and cuttings taken two months later with the following results:—

Plot.	Manurial Treatment per Acre.				Grass, Cwts. per Acre (1916).
	Lime, 1913.	Basic Slag, 1913.	Sulphate of Ammonia, 1914.	Dung, 1914 and 1916.	
1	...	...	...	...	33·9
2	16 cwts.	...	...	...	43·8
3	"	8 cwts.	...	...	94·6
4	"	"	·8 cwts.	...	106·4
5	"	"	...	Total, 14 tons	121·7

These weights of fresh grass represent thus only two months of growth. The greatest increase in the weight of crop was given by the basic slag which also caused the greatest increase in the proportion of clover in the herbage.

II. When we estimate the yields of pastures by keeping production records of the stock grazing on them, we meet with all sorts of difficulties. In the first place we have to assume that the pasture has to be credited with that number of fodder units which the cattle would consume in the shed to give the same performance. This is hardly quite justifiable, except on the plea that no better method is available at present. A cow in the byre does not have to wander round collecting its food; animals under shelter are not subjected to such variable temperatures and weather conditions; but, on the other hand, grazing is a particularly healthy occupation.

Professor Hansson suggests the following rules for estimating the produce of pastures:—

1. The pasture is valued according to the live-weights of the stock and their production.

2. For the bare maintenance of animals at pasture allow per head per day:—

For cattle over 880 lbs. live-wt. .	1 fodder unit per 150 lbs. live-wt.
" " 660–880 " .	" " 140 "
" " under 660 " .	" " 125 "
" horses . . .	" " 110 "
" sheep . . .	" " 100 "
" dry cows, in calf . .	" " 100 "

3. In addition allow for production 1 fodder unit for every 3 lbs. of milk yielded, or/and 3·5[1] fodder units on the average for every 1 lb. of daily gain in live-weight.

4. The total obtained in this way gives the normal pasture-day allowance, from which must be subtracted any hand feeding in order to arrive at the actual pasture consumed.

5. The animals must be weighed at regular intervals, and not simply at the beginning and end of the pasture season.

Where weighing the stock is impossible the following figures may be of assistance. They indicate the total daily fodder units consumed by various classes of stock, from which a rough idea of the pasture consumed may be obtained. The lower figures in each case are near the maintenance level, while the higher figures indicate the highest probable production level:—

	Fodder Units per Head per Day.
Heifers: One to two years old . . .	7 to 10
Heifers: Over two years, in calf . . .	9 „ 12
Dry cows: 900 to 1100 lbs. live-weight .	9 „ 13
Low-yielding cows: 10 to 20 lbs. milk .	9 „ 14
High-yielding cows: 20 to 40 lbs. milk .	13 „ 22
Horses: 1000 lbs. live-weight . . .	9 „ 14
Horses: 1500 „ „	13 „ 21
Sheep: 150 „ „	1·5 „ 3
Sheep: 100 „ „	1 „ 2
Sows: 300 „ „	3 „ 12

These figures are in conformity with the feeding standards which have been given in this *Journal* from time to time in detail. But, perhaps, it will simplify matters a little if we examine a few examples of how this scheme works out in practice.

Cows at pasture are assumed to require 1 fodder unit for each 150 lbs. live-weight per day for maintenance, and, in addition, 1 unit for every 3 lbs. of milk they produce. This gives the total fodder units consumed per day, or what Professor Hansson calls "the normal pasture-day allowance." From this is subtracted the number of fodder units given as supplementary food, and the difference is the number of fodder units credited to the pasture. At Valinge in 1916 the cows were divided into two groups for pasturing—those giving high milk yields and those giving low milk yields. The high milkers averaged 29·3 lbs. of milk daily, and as they weighed about 1100 lbs. their total daily food was assessed at 16·9 fodder units. These cows were milked three times a day, and during most of the grazing season were only at pasture for about four hours between the midday and evening milkings. Their supplementary food consisted mostly of green fodder fed in the byre, and amounted to 9·8 fodder units. The pasture consumed per day was thus 16·9, less 9·8 = 7·1 fodder

[1] This is an average figure for *growing* stock. It is considerably higher for fattening cattle. Thus we get: store cattle 3·3, half-fat 4·4, nearly fat 5·5.

units. For each day these cows were at pasture, the pasture was credited with 7·1 fodder units per cow. The low milking cows averaged 9·9 lbs. of milk, and they put on ·5 lbs. of live-weight per day. Their total food was assessed at 11·9 fodder units per day. They were milked twice daily, and were at pasture usually for eight hours. The supplementary food, mostly green fodder, amounted to only 2·5 fodder units. So each cow consumed 11·9, less 2·5 = 9·4 fodder units of pasture daily.

Young Cattle.—The youngest group of calves, putting on weight at the rate of 2·0 lbs. per day in a special calf pen, had their daily food assessed at 6·6 fodder units. Skim milk, hay and concentrates supplied amounted to 4·0 fodder units, so that the pasture only supplied 2·6 fodder units per head per day. A group of older calves (under one year) had their daily food assessed at 7·7 fodder units. These were putting on weight at the rate of 1·1 lb. per head per day. They required about 3·9 units for maintenance and 3·8 for producing the daily growth; thus we get the 7·7 units daily. The supplementary food in this case was only ·4 units, so the pasture supplied 7·3 fodder units per head per day. Heifers (over one year), putting on 1·2 lbs. per day, were considered to consume 9·9 fodder units; of this ·5 consisted of supplementary food, and 9·4 consisted of pasture. A group of two-year-old heifers (in calf), gaining at the rate of 1·8 or 1·9 lbs. per day, had their daily ration assessed at 12·1 fodder units, of which 11·5 units were pasture.

Work Horses.—These usually pasture only for short intervals, but a group of six grazed undisturbed for twenty-six days, averaged 1·7 lbs. live-weight increase per head per day. Horses can suitably follow cattle on the pastures, as they willingly attack the rough patches which remain behind after cows and young cattle.

Having described the two methods used for estimating the yields of the pastures, it remains to compare the results obtained by the two methods. The first method (by weighing the grass) was employed only in one field in each group of pastures. The results by the two methods do not seem to agree very well.

Estimated Fodder Units per Acre.

	I. By Grass Weighing.	*II. By Stock Control.*
Field I.	2630	1800
„ II.	3430	2730
„ III.	5640	3120

The grass weighings method gives much higher results. The clipped plots in each case formed, of course, only a small portion of the whole field, the rest being devoted to the stock. Professor Hansson points out that the cut plots had a full four weeks to grow between each clipping, while in the case of pasturing the cattle were feeding from five to twelve days, and the pastures had thus only three weeks rest between successive grazings.

An interesting point well brought out in these experiments is

that the gains made on pastures by young cattle depend largely on their condition on going out, *i.e.*, on their previous feeding. The better they have been treated the previous winter the poorer will be the gains made at pasture, This is shown by the following figures relating to a number of young heifers :—

Daily Live-Weight Increase in Lbs.

In Winter.	*At Pasture.*	*Whole Year.*
1·06	·92	·99
·47	1·50	·99

Another point examined was the effect of taking a crop of hay from pasture land. This resulted in increasing the top grasses at the expense of the bottom grasses and clovers ; but the total yield of the pasture in the following year was not adversely affected.

Pastures receiving complete manures, *i.e.*, nitrate of soda, sulphate of ammonia or farm-yard manure, in addition to potash and phosphates, showed thereby increased yields.

Land Settlement in Skye—Migration Scheme.

AMONG the greatest difficulties of land settlement in Scotland have been the pressing demand for holdings from districts where the least land was available and the reluctance of applicants to migrate from one district to another. It was to be expected, of course, that a big proportion of the demand for holdings would come from districts already largely crofterised. In Harris and Lewis this problem was particularly acute. Altogether the Board received from these districts over 2000 applications for new holdings, while, even if holdings of a very small type were formed, the whole of the land available under the Acts could not be made to meet more than a tithe of that demand. What the great majority of the Harris and Lewis applicants desired was a holding sufficiently large to provide milk, butter, eggs and potatoes for the family use, and, if possible, wool for manufacture into tweeds, yet sufficiently small to allow the men to follow their natural vocation—fishing—for the greater part of the year.

For some time the Board had in mind the possibility of a migration movement. When the exhaustion of available land in Lewis and Harris was well in sight, they acquired from MacLeod of MacLeod the estate of Bracadale in Skye. Bracadale appeared to offer just those conditions which are essential for a crofter-fishing settlement: a well-sheltered loch, with inland ramifications teeming with fish of various kinds—even the fickle herring can usually be relied on to pay an annual visit to Loch Bracadale; along the shore, belts of good, green land easily capable of reclamation; and further inland good pasture land for sheep and cattle. Peat ground there was, too, in abundance (although in this respect the settler would do well to calculate if peat is really his

cheapest source of fuel; it takes many a long and arduous day for himself and his wife and family to procure a year's supply of peat-fuel even in a dry season; and dry seasons are the exception in these parts). If Harris and Lewis applicants, then, could be got to leave their beloved Isle at all for elsewhere in Scotland, Bracadale was surely the place for them. Moreover, to the Skyeman, who is less of an amphibian and who derives his living mainly from the land, Loch Bracadale did not so particularly appeal as it did to his neighbours from across the Minch.

The Board decided, after reserving the greater part for the settlement of Skye applicants on large holdings, to attempt to form a settlement of Harris and Lewis men on the North Talisker portion of its newly acquired Bracadale estate. The scheme provides for sixty-eight settlers, each holder to have from 10 to 50 acres in individual occupation (of which in each case some 4 to 6 acres will be actual arable) and a common right in some 3000 acres of pasture. The souming per holding is one horse, 2 cows, 1 follower and 10 sheep. The sheep stock is managed on the club principal and thus makes practically no call on the time of individual holder.

While superficially it may appear undesirable to form holdings of so small a type, it has to be borne in mind that the settlers are expected to depend mainly on the sea for their livelihood, and that larger holdings would make too heavy demands on their time. Moreover, even with a small expenditure of labour properly applied to the holding by the men, a very substantial contribution to the necessaries of life is, in normal years, assured to the family. The value to a family of a generous supply of milk, butter, eggs and potatoes such as should be got from these holdings is obvious; and in addition there is a home, a little cash profit from the club sheep stock and wool for home manufacture.

Two-roomed huts for the temporary accommodation of the family were provided by the Board by means of loans. The huts cost approximately £70 erected on the ground and the loans are repayable by the holders over a period of twenty years, with interest at 1¼ per cent. In addition, each holder is entitled to a loan of £100 to assist him with the erection of a permanent dwelling-house. When the latter is ready for occupation, the hut can be utilised as a steading and, as an inducement to the holder to expedite the provision of a permanent stone and lime dwelling-house, half the cost of the hut will then be written off. A grant in aid not exceeding £6 per family was made towards the expense of removing the family, household effects and stock.

Early in the spring of 1923 a selection of holders was made from amongst numerous ex-service applicants in Harris and Lewis, and in March of that year the first contingent of immigrants—twelve in number—arrived; these were followed at irregular intervals by others. In most cases the holder came first and, if satisfied with the conditions and prospects, sent for his family and effects afterwards.

The wave of emigration which passed over the Hebrides in 1923 threatened for a time to leave the Bracadale migration scheme high and dry: men hesitated in their choice between Canada and Skye, but by January 1924, all the holdings were occupied, and there was still an unsatisfied demand. At the end of January of the present year fifteen families were actually resident on the holdings and there was a population of approximately 100. By the end of summer, when all the families should be on the ground, there will be a population of nearly 300.

The settlers are particularly fortunate in that they and their sons are being employed at good wages on works essential to the settlement. Nearly seven miles of new road and paths estimated to cost over £6000 are under way, fences estimated to cost about £2500 are being erected, and a new pier for the convenience of the settlement is being built at Portnalong.

A settlement such as this necessarily affects the existing facilities of the district as regards church, school and post office. The postal authorities have made temporary arrangements for the delivery and despatch of letters in the settlement, the church authorities have in hand the question of religious services and ministrations, and the education authority have arranged that children of school age will be taught in a corrugated iron building placed at their disposal by the Board until permanent school buildings can be erected. An area of land near the pier has been reserved as sites for church, school, shops, fish-curing stations, etc., and it is expected that in the course of a few years the new community will be functioning normally.

Notes from Craibstone.

Mashlum.—During the past few years trials have been carried out at Craibstone with a view to determining the best mixture of seeds suitable for a spring-sown green crop to be used in early autumn. This subject is of special interest at the present time on account of the great development of the silo. It has been found that for this purpose the best crop in this part of the country is a mixture of beans, peas, tares and oats. Where such a crop is grown, the great majority of farmers sow all these seeds in mixture at the same time. Experiments at Craibstone, however, have proved conclusively the very great advantage of having the beans put in at least one month before the other ingredients. Where the beans have been sown early, it has been found, on an average, that three times the amount of beans has been got in the resulting crops as compared with the same seeding where the beans were sown at the same time as the other constituents.

The actual proportions of the seeds to be used will depend necessarily upon the local soil and climatic conditions, but at Craibstone, on medium soil, the following mixture has given the best results:—

2 bushels Beans.	¾ bushel Tares.
1½ bushels Peas.	3 bushels Oats.

Barley and rye have been tried, but they are found not to be so suitable as oats, because they so readily get into ear and are not readily eaten by stock in this condition.

While, generally, a straw variety of oats has given the best return, it has been noted that in dry seasons grain varieties have given a rather larger crop of straw. On the whole, however, these trials would show that the straw varieties are superior for this purpose.

Lucerne.—In view of the fact that several farmers in this part of the country are sowing lucerne this spring, the following notes on trials carried out with this crop at Craibstone may prove of interest. These trials have shown that, while lucerne suits our climate, it nevertheless requires a good, deep, rich soil, and, further, soil in a very clean condition. The success of the crop will depend very largely upon the cleanness of the soil at the time of sowing, and, therefore, it would be advisable to take two cleaning crops—turnips followed by potatoes—in preparation for sowing out lucerne. Broadcasting has been tried against sowing the crop in rows, but broadcasting has turned out a failure on account of the fact that the crop is entirely overrun with annual weeds such as chickweed, annual meadow grass and hemp nettle. When sown in rows, the rows should be not less than 10 inches apart, aud the crop should be hoed thoroughly in the spring or early summer.

Different rates of seeding have been tried, varying from 16 to 30 lbs. of seed per acre, and it has been found that the thinner seedings gave the better return. With thin seedings, however, the plants more readily get into a woody condition. This, however, may be counteracted to a certain extent by cutting early. Where sown along with a nurse crop, or as a constituent in a grass and clover seed mixture, the lucerne has turned out a total failure.

Inoculation of the soil where lucerne has not been grown previously has been found to be of very great advantage. Two methods of inoculation have been tried, viz., with pure cultures and with soil taken from a plot on which lucerne has been grown successfully for some time. As a general rule, it has been found that the inoculation by soil is the better method. The probable reason for this is that in many cases the pure cultures are not perfectly fresh when used.

When well established, two cuts should be got every season, and we have found that under our soil conditions, which are not the most suitable, the plants remain strong and healthy for at least five years.

Trials with Samples of Red Clover.—Trials have been carried out during the past two or three years with samples of red clover from different sources, and, on the whole, have confirmed the results of previous years, which have been published already. Late-flowering red has given, in almost every case, a 25 per cent. heavier crop in hay than the broad-leaved type. On the other hand, there has been practically no aftermath after the late flowering. This, however, is to a considerable extent counter-balanced by the larger amount of red clover found in the second and third year by late-flowering. It is better, therefore, to use

a mixture of the two types rather than either singly. Amongst the late-flowering samples those from Montgomery have, as a rule, been best here.

On the whole, the trials show the marked superiority of genuine English broad-leaved red as compared with samples from any other country. Samples from Southern Europe, particularly from Italy, have been almost complete failures.

One interesting point has emerged from the trials, however, and that is that certain samples of English-grown red clover have turned out comparative failures, and apparently the only explanation of this is that, although grown in England, the seed used has been imported seed. Such samples are quite correctly described as England-grown red clover, but to all intents and purposes they are really foreign clovers.

Scottish Egg-Laying Tests.

THE Board of Agriculture for Scotland are in process of making arrangements to conduct a series of egg-laying tests at Seafield on the Farm of Boghall, Loanhead, Midlothian, which the Board propose to lease for a period of years from the Edinburgh and East of Scotland College of Agriculture. It is proposed to commence the tests in October of the present year.

The main purpose of egg-laying tests is to enable poultry keepers to evolve good laying strains of birds by making available authoritatively tested stocks, and thereby to increase the egg production throughout the country. Besides making known the best strains of layers the tests excite much general interest in the poultry industry, they provide valuable demonstrations in poultry management, housing and feeding, and they familiarise the poultry keeper with the practice of trap-nesting, without the aid of which he is not able to maintain at its highest the productive capacity of his stock.

The utility of laying tests has been demonstrated in other countries. In England there are at present several open tests carried out by various agencies, some being subsidised from public funds either directly or indirectly. There are also local tests, as for instance those carried out under the auspices of various County Councils. An official test has been conducted at the Munster Institute, Cork, since 1910, and one of the first acts of the new Ministry of Agriculture for Northern Ireland was to institute a test for 1922-23. Regular competitions are held in Australia, New Zealand, Canada, the United States of America, France and Denmark, mostly by State agency.

While much has been done in Scotland to educate poultry keepers in the advantages of keeping birds of pure breed and good laying strains, the Board are advised that the industry will receive an impetus from the institution of well-conducted egg-laying tests. It may be mentioned that in 1913 the average egg production in Scotland was calculated to be only seventy-four eggs per bird per year; it is obvious, therefore, that there is considerable scope for the improvement of the industry in Scotland.

During 1923 the Scottish National Poultry Council, an association of poultry keepers, was formed as a result primarily of the demand among poultry breeders for the institution in Scotland of a series of egg-laying trials. It is in consultation with an Advisory Committee composed of representatives of this association, the Colleges of Agriculture, the Royal (Dick) Veterinary College and Research Institutes that the Board are making arrangements for a Scottish test. The tests will be under the control of the Board, who will be assisted by an Executive Committee nominated by the afore-mentioned Advisory Committee and the Board.

It is proposed that the tests shall extend over a period of forty-eight weeks beginning in October 1924, and ending in September 1925. It is probable that competing pens will consist of six pullets or ducks hatched during the year 1924, the birds in each pen being of one breed and of one variety of the breed. Records will be kept and published of the number and grade of all eggs laid and of the total number of such eggs produced by each pen. All pure breeds will be eligible for the test, provided they are the property of and bred from stock the property of the competitor.

Detailed rules for the tests will be published at an early date, and will contain full information for the benefit of intending competitors.

Potato Culture in Scotland.

REPRESENTATIONS were recently made to the Board of Agriculture for Scotland that the work in connection with potato culture which has been carried on in Scotland during the past few years was of sufficient importance to warrant measures being taken to give the matter greater publicity. A meeting, representative of potato growers, traders and scientific workers, was accordingly convened to consider what steps should be taken to achieve this purpose, and it was finally decided that a conference should be held this summer at which an opportunity would be afforded visitors of inspecting the potato trial which will be in progress at the Board's experimental farm at East Craigs, and of hearing a full explanation of the work carried on there.

A small sub-committee, appointed to co-operate with the Board in arranging details, has since decided that the conference should be held on Wednesday and Thursday, 20th and 21st August, and has drawn up the following provisional programme :—

Wednesday Morning: Meeting in Edinburgh.—Introductory paper : "General Review of the Board's Work in the Registration of Immune Varieties of the Potato and Certification of Potato Stocks" (Jas. Wood, O.B.E., Member of the Board of Agriculture for Scotland); discussion. Paper : "Field Trials of Potato Varieties" (J. A. Scott Watson, Professor of Agriculture, University of Edinburgh) ; discussion.

Wednesday Afternoon: At Plant Registration Station, East Craigs.—Field lecture on "Classification of Potato Varieties with Reference to Registration Scheme" (A. Millar, B.Sc., Supervisor of Potato Trials, Board of Agriculture for Scotland Plant Registration Station). Demonstration on the general work carried out at the Plant Registration Station as indicated in the introductory paper.

Wednesday Evening.—Dinner.

Thursday Morning: At Plant Registration Station, East Craigs.—Field lecture and demonstration on "Practical Effects of Degenerative Diseases and Variations on Potato Stocks" (T. Anderson, M.A., B.Sc., Director of Seed-Testing Station, Board of Agriculture for Scotland).

Thursday Afternoon: Meeting in Edinburgh.—Paper: "Potato Diseases" (G. H. Pethybridge, Ph.D., Plant Pathologist, Ministry of Agriculture and Fisheries, Harpenden); discussion. Paper: "Potato Breeding" (Montagu Drummond, B.A., F.L.S., Director, Scottish Society for Research in Plant Breeding); discussion.

It is not proposed to issue formal invitations, but intimations are to be sent to all interested potato breeders, to farmers' and potato trade associations, and to the Dominions and foreign countries where potato culture is important.

It is hoped that the presence of a large number of visitors from abroad to the British Empire Exhibition at that time will result in a large representation of foreign countries and colonies at the conference, and that from the publicity given to the work done in Scotland in connection with potato culture considerable benefit will accrue to the potato-growing industry in this country.

Poultry-Keeping in the Town.

THE results of a single year's experience of intensive poultry-keeping in a city suburb may be of interest as showing what may be achieved with a small amount of available back-garden space.

Six White Leghorn pullets were secured at the end of November 1922 from the West of Scotland College of Agriculture Poultry Department at Kilmarnock. These were accommodated in a house with scratching shed attached, measuring 12 feet by 4 feet by 4 feet. In the late spring of 1923 an outside run of about 10 feet square was added. Dry sand was used to cover the floor of the house, but for the scratching shed a quantity of straw was provided, which was quickly ground to chaff by the birds.

Careful records of feeding and egg-laying were kept. In the scratching shed mixed grain was scattered twice daily, about $\frac{2}{3}$ lb. each time, and bruised oats were available in an open hopper all

day. In the open run fresh water and green stuff were set down each morning, and at noon a mash composed of poultry meal and household scraps. The weekly cost of feeding worked out at 3¼d. per bird. It may be mentioned that one pullet died on 25th August apparently from over-eating.

The egg-laying record for the complete year, with monthly values somewhat below the prices charged by the retail dealers, is as follows :—

Month.	Number of Eggs.	Value per Dozen.		Total Value.		
1922.		s.	D.	£	s.	D.
November (2 days) . .	3	4	0	0	1	0
December	77	4	0	1	5	8
1923.						
January	59	4	0	0	19	8
February	79	3	0	0	19	9
March	77	2	0	0	12	10
April	117	1	6	0	14	7
May	105	1	6	0	13	2
June	119	1	9	0	17	4
July . . . . ,	128	2	0	1	1	4
August	111	2	3	1	0	10
September	80	2	6	0	16	8
October	85	3	0	1	1	3
November (28 days) .	50	3	0	0	12	6
	1090			10	16	7

The egg-laying average, allowing for the loss of one pullet during the summer, is therefore 190.

The following statement shows the financial aspect of the experiment :—

EXPENDITURE.

I. *Capital*—

Poultry house and hopper	£7 8 3
Six White Leghorn pullets and carriage on same . .	3 6 6
Material for outside run	0 17 6
	£11 12 3

II. *Maintenance*—

2 Cwt. mixed grain	£1 8 0
2 „ laying meal	1 9 0
2½ „ bruised oats	1 13 6
2 Stone grit	0 2 8
Straw	0 0 6
Waste greens . . . . ,	0 1 10
	£4 15 6

PROFIT AND LOSS ACCOUNT.

Income.		*Expenditure.*	
Value of eggs (as per record) . . .	£10 16 7	Maintenance (as per record)	£4 15 6
Feeding stuffs on hand ·		Depreciation—	
$\frac{2}{3}$ Cwt. bruised oats . . £0 9 4		Loss of pullet . £0 10 6	
$\frac{1}{3}$ Cwt. meal . 0 5 0		5 Pullets @ 5/6 and carriage 3/6 1 11 0	
	0 14 4	House, etc., say 20% . . 1 15 9	
			3 17 3
		Balance	2 18 2
	£11 10 11		£11 10 11

Without taking note, therefore, of such factors as interest on capital and value of labour, which in the system of management followed was negligible, the records show a profit of slightly over 10s. per pullet.

Committee on Agricultural Education.

THE Secretary for Scotland has appointed a Departmental Committee to consider and advise regarding the general organisation and finance of agricultural education and research in Scotland. The members of the Committee are:—The Honourable Lord Constable, C.B.E., chairman; Sir James Adam, C.B.E., K.C.; Mr David Black; Mr Joseph F. Duncan; Captain Walter E. Elliot, M.C.; Miss Elizabeth S. Haldane, C.H.; Mr James Keith; Dr George Macdonald, C.B., F.B.A., LL.D., with Mr A. M'Callum of the Board of Agriculture for Scotland as Secretary.

The existing organisation of agricultural education has been built up during the last twenty-five years and it is appropriate that it should now be reviewed in order to ensure that development is taking place upon right lines and that all the agencies involved are so co-ordinated as to secure the highest efficiency.

The Committee have already held two meetings and have arranged a programme of inquiry into all the departments of the organisation both of agricultural education and research, and their finance, as well as of comparison with the systems prevailing in the colonies and in foreign countries.

Scottish Students' Appointments.

THE following is an extract from *Nature*, No. 2826, Vol. cxii.:—The North of Scotland and the Edinburgh and East of Scotland Colleges of Agriculture append to their calendars for 1923–24 lists of appointments gained by their students. They illustrate the Scottish propensity, referred to in Mr Rudyard Kipling's recent rectorial address, for "raiding the world in all departments of life —and government." The lists include posts in England (53), Canada, the United States, South America, the West Indies, Australia, New Zealand, South, West, East and Central Africa,

the Sudan, Egypt, Cyprus, Hungary, India, Burma, Ceylon, Straits Settlements, Malay States, Java, Sumatra, Borneo, Fiji and Hawaii; only 60 out of the 280 were in Scotland.

SUMMARY OF ACREAGES OF POTATO CROPS OF THE IMMUNE VARIETIES INSPECTED FOR PURITY IN SCOTLAND DURING 1923.

VARIETIES.	Percentage of Purity.			TOTALS.
	99·5 per cent. and above.	Below 99·5 per cent. to 97 per cent.	Below 97 per cent.	
Great Scot	3,749½	643½	462½	4,855½
Golden Wonder	3,268¾	322¾	144½	3,736
Kerr's Pink	3,038	289	96	3,423
Majestic	1,621½	378¾	110½	2,110¾
Tinwald Perfection	1,087½	59¼	55¼	1,202
Ally	499¼	58¼	19	576½
Crusader	532¼	22½	4¼	559
Rhoderick Dhu	390¾	32¼	28¼	451¼
Langworthy	137½	48¼	84½	270¼
Abundance	181½	36½	20½	238½
Arran Comrade	187¼	33½	4	224¾
King George	161¼	28¾	12	202
Witchhill	128¾	13¼	14¾	156¾
Dargill Early	122¾	11¾	...	134½
Katie Glover	121	11½	...	132½
Immune Ashleaf	87¾	2¼	...	90
Arran Victory	87	...		87
Others	424¼	42¾	72¾	539¾
	15,826½	2,034¾	1,128¾	18,990

SUMMARY OF ACREAGES OF POTATO CROPS OF THE NON-IMMUNE VARIETIES INSPECTED FOR PURITY IN SCOTLAND DURING 1923.

VARIETIES.	Percentage of Purity.			TOTALS.
	97 per cent. and above.	Below 97 per cent. to 94 per cent.	Below 94 per cent.	
King Edward	8,388¼	583¾	501¾	9,473¾
Arran Chief	3,029¼	431¾	518¾	3,979¾
Epicure	1,266½	322¾	388¼	1,977½
Sharpe's Express	1,264¼	117	84¼	1,465½
Eclipse	1,159¼	80¾	89	1,329
Duke of York	915½	74½	71½	1,061½
British Queen	695¾	68¾	160	924½
Field Marshal	440¾	...	19¾	460½
Up-to-Date	277¾	14	32	323¾
May Queen	117¾	4	14½	136¼
Ninetyfold	87½	9½	10¼	107¼
Others	331¾	21¼	47½	400½
	17,974¼	1,728	1,937½	21,639¾

Agricultural Conditions.

THE weather during December was unsuitable for outdoor work and in most districts ploughing made little progress during the month. The normal work of the season was also retarded to a greater or less extent during the greater part of January, the weather being unsettled, with occasional falls of snow and recurring frosts. Conditions improved during the last week or ten days of January, however, and enabled field work to be proceeded with more satisfactorily. During February there were occasional short spells of inclement weather, with snow in some districts, but the rainfall on the whole was light. As a result of the drier conditions, and the improved state of the soil, there was little or no interruption to outdoor work and arrears of cultivation were to a great extent overtaken. Considerable progress was made during February with the planting of early potatoes in Ayr, while in Roxburgh a beginning was made with the sowing of oats and barley.

Wheat-sowing was completed or well advanced in most districts by the end of December and speaking generally the seed was got in in good order. Where sown early the braird is healthy and vigorous, but on wet land and in late-sown areas germination and growth have been rather slow. At the end of February the appearance of the crop was barely up to the average in Berwick, but elsewhere the general prospects at that date were fairly satisfactory. No reliable estimates of the acreage under wheat this year are yet available, but according to the reports received it would appear that the area sown will show an appreciable diminution.

The condition of last year's potato crop is generally reported to be fair. In several districts there has been more wastage than usual owing to the potatoes being damaged by frost before being lifted. Otherwise, however, the crop is comparatively free from disease and no reports of sprouting in the pits were received up to the beginning of March. In the western islands the yield was so small that little or no pitting was carried out, while in Orkney the tubers were of very inferior quality.

Ewes on arable farms wintered fairly well and the lambing prospects, as reported at the end of February, were quite up to the average. In the case of hill flocks, however, the prospects were not so bright, as the ewes had not fully recovered from the effects of the inclement weather during the latter months of 1923. Lambing was in progress during February on arable farms in Forfar, North-East Fife, Berwick, North-West Lanark and Dumfries, and amongst special flocks in Roxburgh, Renfrew, North Ayr and some districts of Aberdeen. Elsewhere, however, lambing generally had not commenced at the end of February. The proportion of twin lambs during February was fairly satisfactory in Dumfries and North-East Fife, but in Berwick the crop was hardly up to the average.

The turnip crop has kept well on the whole and the supply is adequate except in Dumbarton, Stirling, North-West Lanark,

Renfrew and some parts of Aberdeen. In Berwick and Roxburgh turnips and swedes left in the fields grew throughout the winter and proved a much heavier yield than at one time anticipated. Keep of all kinds is deficient in Caithness and Ross, while in Forfar, North-East and Central Perth, Dumbarton and North-West Lanark straw is rather scarce. Elsewhere the supplies of fodder are sufficient for requirements.

The supply of regular workers and of casual labour, in most districts, is ample for present requirements. In Dumfries, however, experienced farm hands are difficult to secure, while in North-East Perth there is a shortage of skilled horsemen.

RECENT PERIODICAL LITERATURE.

A number of the following extracts and summaries are taken from recent bulletins of the International Institute of Agriculture. Full references to the bulletins, and to the original publications quoted therein, may be obtained on application to the Secretary, Board of Agriculture for Scotland, York Buildings, Edinburgh.

Studies in Crop Variation and Response to Manures. *R. A. Fisher and W. A. Mackenzie (Rothamsted Experimental Station, Harpenden), The Journal of Agricultural Science, Vol. XIII., Part 3, Cambridge, 1923.*—It is not infrequently assumed that varieties of cultivated plants differ not only in their suitability to different climatic and soil conditions, but in their response to different manures. Since the experimental error of field experiments is often under-estimated, this supposition affords a means of explaining discrepancies between the results of manurial experiments conducted with different varieties; in the absence of experimental evidence adequate to prove or disprove the supposed differences between varieties in their response to manures, such explanations cannot be definitely set aside, although one very often suspects that the discrepancies are in reality due to the normal errors in field experiments.

On the other hand, if important differences exist in the manurial response of varieties, a great complication is introduced into both variety and manurial tests, and the practical application of the results of past tests becomes attended with considerable hazard. Only if such differences are non-existent, or quite unimportant, can variety tests conducted with a single manurial treatment give conclusive evidence as to the relative value of different varieties, or manurial tests conducted with a single variety give conclusive evidence as to the relative value of different manures.

In a recent experiment at Rothamsted twelve potato varieties were tested with six manurial treatments. The author gives in five tables the results of this experiment. The data show clearly significant variation in yield due to variety and to manurial treatment. There is no significant variation in response of different varieties to manure.

The Minimum Temperature of Germination of Seeds. *F. A. Coffman, Journal of the American Society of Agronomy, Vol. XV., No. 7, Albany, N.Y., 1923.*—Little information apparently exists upon the subject of minimum temperatures of germination of seeds of most of our commonly grown plants. The author's objects in these experiments were to determine (1) The minimum temperatures at which seeds of different common crop plants would germinate; (2) the minimum temperatures at which satisfactory percentages of germination may be expected and the variations between such temperatures in different crops; (3) whether lower temperatures than those commonly used in seed testing laboratories would be beneficial in the germination of seeds.

Seeds of different species germinate very differently at different temperatures. Within a given species, starchy seeds appear to be unable to resist low temperatures to the same degree as the more oily seeds, without injury and reducing germination percentages. All of the small grains will germinate at the temperature of melting ice. Oats appear to be more affected by low temperatures than the other small grains. The strength of germination under freezing conditions appear to be in the following order: barley, rye, wheat, oats. It has been noticed that under field conditions spring barley and rye will germinate more quickly than spring wheat and oats during seasons of low temperatures. Of our commonly grown crops, the seed of the clovers will germinate more readily at low temperatures than any of the others. From the results obtained in these tests it appears that it would be advantageous to use lower temperatures for the germination of clovers and cereals than those now employed in seed testing laboratories.

Experiments with Cereals at Ontario Agricultural College (Canada).--The Ontario Agricultural College has been the great factor in increasing the yield of barley, oats and winter wheat in this region.

The barley crop increased on an average 17·44 per cent. per acre for the years 1902-1922, and this was largely due to the distribution to the farmers of the Mandschewri barley in 1892, and the O. A. C. No. 21, in 1906. The experiments made at the College during a period of thirty-three years have shown that the average yield of the Mandschewri barley has surpassed that of the common six-rowed variety by 10 bushels per acre per annum; while in a period of seventeen years, the O. A. C. No. 21 has proved superior to the same variety to the extent of producing 11 bushels more per acre per annum. The O. A. C. No. 21 is a six-rowed, bearded barley with stiff straw and white grain of good quality. For some years past. scarcely any other variety has been grown in Ontario.

The large increases observed in the oat crops is apparently due to a considerable extent to varieties introduced by the College; the Vicks' American Banner oats (now abbreviated to Banner) were imported from the State of New York in 1891. In the College tests the Banner oats were surpassed by the Siberian, imported from Russia, by an average of 3·9 bushels per acre per annum from 1891 to 1902, and by the O. A. C. No. 72 by an average 9·7 bushels per acre for the past sixteen years.

The O. A. C. No. 72 was started at Guelph from a single seed in 1903; in comparison with Banner, it has about 2 per cent. less hull and requires exactly the same number of days to reach maturity.

Dawsons' Golden Chaff variety of winter wheat was distributed from the College to Ontario farmers for the first time in 1893; and for a long time it has been the most extensively grown winter wheat in the Province. The O. A. C. No. 104 was originated at the College by crossing Dawson's Golden Chaff and Bulgarian. It is a heavy yielding, white wheat, without awns and with white chaff. It was distributed throughout Ontario for the first time in 1916, and is now increasing rapidly.

The distribution of seed of these varieties has necessarily been confined almost entirely to the farmers of Ontario. At present, however, they are all being grown by members of the Canadian Seed Growers' Association (with headquarters at Ottawa).

The Quality of Selected and Hybrid Swedish Wheat. *Å. Åkerman, Tidskrift för Landtman, No. 13, Stockholm, 1922.*—The object of the selection work begun in 1880 by the Seed Society at Svalöf and its branches was to unite in one type of autumn wheat, in the best possible proportions, the characters of productiveness, strong straw and cold resistance.

The question of the quality of the product was for a long time regarded as being of secondary importance. It is only quite recently, as a result of the special condition of the market induced by the war, and the great increase of grain production in Sweden, that the attention of expert breeders of selected seed has been seriously directed to the improvement of the grain.

Before, however, actual true selection in this direction can be undertaken, it is necessary to determine the real differences between the selected types and the native types, and study the nature of these differences in order to obtain some data that will guide the selectionist in his choice of the best methods of attaining his objects surely and rapidly.

The first difference noticed on comparing Canadian Red Fife wheat with Swedish Pansar is that of the water content, which amounts respectively to 11-13 per cent. and 15-19 per cent. Before the grain is ground at the mill it is first soaked, and then dried till it contains 16 per cent. of water. It can be readily understood that the American wheat with an average water content of 12 per cent. can quickly increase it by 4 per cent., thus giving a yield 5 per cent. higher than that of the Swedish wheat with an average water content of 17 per cent.

The great virtue of imported hard wheats is their capacity to absorb and retain a larger amount of water, which renders the bread more porous, bulky and digestible, while at the same time improving its appearance.

This property, however, is more advantageous to the baker than to the consumer, who, when he buys bread made from American wheat, obtains for equal weight many less calories than from bread made from Swedish wheat. The present mixture, which is composed of Swedish flour to which has been added 30 per cent. of flour made from hard wheat, seems to satisfy the requirements of bread-making. This mixture absorbs a little less water than pure American flour, gives 450-490 cc. of bread per 100 gm. of flour, and bakes easily and well.

According to the author, the wheat produced in Sweden should contain about 15 per cent. of water. (Pansar, 17 per cent.).

It is very advisable that the work of crossing and selection already begun at Svalöf should be continued with a view to improving the types obtained, especially as regards the requirements of South Sweden.

Red Fife Wheat. *Report issued by the Incorporated National Associations of British and Irish Millers, London Corn Circular, Year 80, No. 75, London, 1923.*—The varieties of wheat grown in England, with the exception of the new one, Yeoman, are not suitable for the commercial production of bread without the addition of imported wheat. If home-grown varieties can be produced that are satisfactory to the farmer, miller and baker, the prospects of wheat-growing in England may be revolutionised.

Red Fife wheat, imported in 1902 from Canada and grown successively during the past twenty-one years, yields flour of excellent quality, and has been used by Prof. Biffen in the evolution of new varieties.

The appearance of a wheat is not a correct index of its quality, nor is the percentage of dry gluten a correct index of a flour's strength, as determined by baking trials. By the term "strength" is implied the capacity of a flour to yield large, shapely loaves.

The principal conclusion drawn by Messrs A. E. Humphries and R. Hutchinson from a series of tests made on Red Fife wheat grown at eleven different places in England are:—

(*a*) That after twenty-one years of continuous production in England, Red Fife retains its distinguishing characteristics.

(*b*) When grown in some environments its strength, judged by appearance, seems to have diminished, but baking tests show that even in those cases it retains its distinctive characteristics.

(*c*) That whereas flour from ordinary English wheat cannot be subjected to long processes of baking, the Red Fife, grown for twenty-one years in England, behaves in this respect quite as satisfactorily as No. 1 Northern Manitoba.

(*d*) That its characteristics are not substantially affected even if the wheat contains soon after harvest from 18 to 21 per cent. of water, but remains free from sprouted grains.

(*e*) The differences in gluten content are not correlated to the differences in the volume of the loaf.

(*f*) That Red Fife almost invariably yields in panary fermentation an insufficient quantity of gas, unless some form of yeast food is used.

The Value of Mud. *F. Arnhold (Institute of Agriculture of the University of Leipzig, Germany), Landwirtschaftliche Jahrbücher, Vol. 58, No. 2, Berlin, 1923.*—The mud spoken of in this article is a deposit formed at the river mouths of North-West Germany and along the coast, composed of clay, sand, calcareous and humic substances containing debris of organic origin. When freshly laid down, this mud is dark blue and somewhat plastic, later it becomes more friable and greyish in colour. In the neighbourhood of its deposition this sediment has long been used for improving poor land. It is especially suited to leguminosae, but has also been employed successfully as a fertiliser in the case of cereals, roots and meadow clovers,

The *mechanical composition* of the mud varies very greatly according to its formation. It has been found to contain 5 to 65 per cent. sand, and 85 to 35 per cent. clay.

Its *mineral composition*, on the other hand, is surprisingly uniform. This mud regularly contains about 7 per cent. calcium, about 0·8 per cent. potash, about 1·8 per cent. magnesia, 0·2 per cent. phosphoric acid and 0·5 per cent. nitrogen.

The sea-mud may be said to be chemically composed for the most part of colloidal silica, clay and humic substances. It contains a remarkable number of algae, especially of diatoms, and as the frustules of the latter, together with shells, make up 5 per cent. of the mud, it is rich in silica and calcium carbonate, which promote bacterial development.

The organic remains, as well as the clay, calcium and silica have a favourable action upon soil dressed with this mud, but the chief manurial value of the mud consists in the *large number of bacteria it contains*. The author found free-living forms of these micro-organisms, such as *Azotobacter*, *Radiobacter*, etc., bacteria living in symbiosis with green plants, and sulphur bacteria as well as those forms which decompose organic matter with the formation of ammonia. The nitrifying bacteria, *Nitrosomus* and *Nitrobacter*, were especially numerous. The latter is not destroyed by the ammonification bacteria. It is true that loss of nitrogen due to the action of denitrifying bacteria occurs in the recently deposited mud, but after some time all these bacteria perish with the sole exception of *Bac. fluorescens liquefaciens*.

The good results obtained with this mud are to be attributed to three factors: (1) the improvement of the physical composition of the soil; (2) the increase of nutritive substances; (3) the introduction of very active bacteria. The last factor is of special importance, as it renders superfluous the application of any nitrogenous fertiliser. The mud is used for poor land at the rate of 80-100 m^3 per hectare, 80 kg. of potash and 100 kg. phosphoric acid being also applied.

Mud suspensions can be used for inoculating the seed of leguminosae in order to assist the formation of root-nodules.

The author strongly advocates the employment of this mud on a large scale, especially in the case of uncultivated land that has been cleared. The reclamation of such land is at present a question of the greatest importance in Germany.

The Effect of Potassium and Magnesium upon the Quantity and Quality of the Potato Crop. *D. Marholt, Die Landwirtschaftlichen Versuchs-Stationen, Vol. C, Part 6, Berlin, 1923.*—The author gives a summary of the literature (dating from the time of Liebig), that deals with the effect of magnesium upon plants, and then passes on to describe his own experiments made during the three-year period 1917-1919, in the field belonging to the Chemical Laboratory of Giessen (Germany), on an alluvial clay of great water-retaining capacity. The objects of the experiments were to determine how far the quantity and quality of the crop were influenced by: (1) various magnesian salts; (2) the separate introduction of the chloride, sulphate and carbonate of magnesium into a complete fertiliser; (3) the application of the salts combined with green manuring such as hop clover

(*Trifolium procumbens*); (4) fertilisers like those mentioned in 2 and 3 supplemented with stable-manure.

The mineral fertiliser was composed of: sulphate of ammonia (60 kg. nitrogen per hectare); basic slag (110 kg. of phosphoric acid per hectare); potassic and magnesian salts (100 kg. of oxide of potassium or magnesium per hectare). The stable-manure was applied at the rate of about 400 quintals per hectare.

The results obtained show that:

(1) The salts of magnesium present in the soil have no favourable effect upon potatoes; the salts containing chloride of magnesium decrease, as compared with a complete fertiliser, the starch content of the tubers.

(2) In fertilisers that do not include substances forming humus, magnesian salts have very little effect upon the potato crop. In many cases the application of sulphate of potassium alone produces as large, or almost as large, crops as are obtained with potassic salts + magnesian salts. Sulphate of magnesium sometimes increases the yield; the carbonate and chloride are both less effectual.

(3) The effect of a complete mineral fertiliser is greatly increased by the addition of organic manure. Green-manuring with hop clover considerably intensifies the favourable effect of a potassic-magnesian fertiliser, when the latter is applied in the form of a sulphate. The absolute starch yield generally increases with the potato crop, but the starch content of the tubers is decreased by the green-manure, especially if this is applied at the same time as a complete mineral fertiliser (nitrogen, potassium, sulphur). The percentage of starch in the potatoes is, on the other hand, slightly increased if sulphate of magnesium is also introduced.

(4) The application of stable-manure increases the good effects of mineral fertiliser still more than green-manure. A complete mineral fertiliser added to stable-manure produces a crop of tubers 20 to 40 per cent. higher than can be obtained when green-manure is added to the organic manure, and 50 per cent. higher if it includes the sulphates of potassium and magnesium. The effect of stable-manure upon the starch content of the tubers is similar to that of green-manure.

The use of sulphate of magnesium as a fertiliser for potatoes is only to be advised when it is added to stable-manure, applied at the same time as a complete mineral fertiliser.

The Constitution and Manurial Value of Low Grade Basic Slag. *D. N. McArthur, Journal of the Society of Chemical Industry, Vol. XLII., No. 20, London, 1923.*—The basic process for the manufacture of steel has recently undergone many changes, and the basic open-hearth fluor-spar slags are not comparable in fertilising value with the Bessemer slags, and the citric-solubility test is merely empirical in estimating their value.

The author made a great number of chemical and microscopical examinations of open-hearth slags, and carried out pot and field trials to ascertain the relation between their constitution and the manurial value.

The conclusions drawn from the experiments were that open-hearth fluor-spar slags of low phosphate content have a distinct fertilising value, and could be used to replace ground limestone in agricultural practice. The experiments showed clearly the importance of fineness of grinding on the availability of slags.

Phosphate Reserves of Russia. *Prjanischnikow, Zeitschrift für Pflanzenernährung und Düngung, Vol. II., No. 6, Leipzig-Berlin, 1923.*—The phosphate question occupies as prominent a position in the fertiliser problem in Russia as it does in Germany in spite of the different development of the rural economy of the two countries.

Germany, notwithstanding her intensive cultivation, has been able by means of her chemical industry to obtain all the potash and nitrogen she needs, but since she possesses few, or no, deposits of natural phosphorite, she has great difficulty in satisfying her phosphate requirements.

Russia, on the other hand, has hitherto been a country of extensive cultivation, and consequently of low yields. In exporting countries where wheat is cheap, the crop returns are always less than in importing countries. The fertilisers commonly applied in Western Europe could not be used in Russia on account of their prohibitive price; in the wheat-growing provinces nitrate, for instance, costs three and a half to four times as much as barley. The high price of fertilisers, and not the Russian peasants' lack of technical knowledge, has prevented their application to the land. Further, the soils of Southern Russia (Black Soils) are so rich in nitrogen, that leaving the fields fallow produces an accumulation of nitrates. The soils of Northern Russia need fertilisers, but the sole manure generally available is dung or clover; only in the case of sugar beets or kitchen-garden crops could nitrate be afforded. The same may be said of potassic fertilisers, although Russia possesses a supply of potash in the form of ashes (annual production 1·5 million tons).

The question of phosphates is quite different; nearly all the Russian soils, including the black soils, react to a phosphatic fertiliser, and even before the war more or less phosphates were applied.

Now, however, the conditions have entirely changed, for as super-production has ceased in the South, the northern areas are forced to produce their own wheat, and since dung is lacking, the only course is to use mineral fertilisers, and especially phosphates. Russia possesses extensive deposits of phosphorite that could be worked, and even exported, if means of transport were established. The whole question has been studied lately, and the findings of the Commission appointed to investigate these deposits have been published in two series by the Moscow Academy of Agriculture (Petrowoko-Rasumowske) under the titles of: I. Geological Researches on Russian Phosphorites; II. The Chemical Treatment of Russian Phosphorites and Researches on their Application (published in 1919 and 1921).

The preliminary investigations have shown the existence of 5568 million tons of phosphorite which is, however, of very varying quality.

The phosphorites with a low percentage of phosphoric acid can be used in two ways:—

(1) Transformed into a 40 per cent. double superphosphate or precipitated phosphate.

(2) Applied in a pulverised form without any chemical treatment.

The author has studied the extraction of these phosphorites by treatment with sulphuric acid in the laboratory, and is of opinion that the precipitated phosphate process is likely to be the one most adopted in future.

Pulverised phosphorite is to be recommended in the case of certain plants and soils, and for use in conjunction with some other fertilisers.

The author is of opinion that the phosphorite deposits of Russia will soon become of considerable importance.

Spraying and Increase of Potato Crop. *F. H. Chittenden and W. A. Orton, U.S. Dept. Agr. Farmers' Bulletin No. 1349.*—Between 1920 and 1921, the estimated average yield of potatoes in the United States fell from 110 bushels to 91 bushels per acre, and it has been estimated that the total loss from potato diseases and insects in the United States is frequently as much as 100,000,000 bushels a year. In 1912, in New York alone the potato crop was reduced 20,000,000 bushels as the result of a late blight. The enemies of the U.S. potato crop are generally either insects such as the Colorado beetle, blister beetles, flea beetles, caterpillars, aphids or plant lice, or foliage diseases such as late and early blight. The damage caused by all of these can be very much reduced by spraying, and there can be no doubt that a considerable addition to the average crop results. At the Vermont Experimental Station, over a 20-year period, spraying resulted in an average gain of 105 bushels per acre, 64 per cent. productivity over the unsprayed areas. The Bulletin discusses the methods adopted against each pest, but against most of the injurious insects and plant diseases, Bordeaux mixture containing lead arsenate was found to be effective. For sucking insects,

however, such as green-flies, a contact insecticide such as nicotine sulphate or emulsions were best. Instructions are given for the preparation of Bordeaux mixture, and the types of spraying apparatus most useful for different grades of potato cultivation are described.

Numbers of Wireworms. *A. Loebuck, Jour. Ministry Agric., Feb. 1924.*—The numbers of wireworms present in farm soils were estimated from actual counts made on test samples 1 foot in depth, having a surface 1 foot or 9 inches square. The results were interesting, for the numbers from pastures were found to vary from 103,000 to 900,000 per acre, the average being 305,000, while in four arable fields over five years in cultivation the number varied from 44,000 to 95,000 per acre, the average being 81,000. The wireworms were approximately four times more numerous in grass land than in arable land. Equally convincing were the results that followed the examination, year by year, of land that became cultivated after lying in pasture. One such field, first ploughed in the autumn of 1914, has witnessed the steady reduction of its wireworm population, from 900,000 in 1915 to 6000 in 1922, by steps which tell their own tale: 1916, 850,000; 1917, 680,000; 1918, 440,000; 1919, 283,500; 1920, 32,700; 1921, 21,800; 1922, 6000. Other similar annual observations gave similar consistent results. Cultivation is the most effective destroyer of the wireworm. Further observations showed that the cereal crops which produced best results on wireworm infected fields were oats of the older varieties, while barley was worst and wheat intermediate; of other crops, beans and peas were sure croppers, potatoes generally did well, but turnips and mangolds were liable to serious damage.

The Cabbage Maggot and its Control. *G. W. Herrick and W. Colman, Cornell Univ. Exp. Stn., Bull. 413.*—Since its introduction from Europe to North America the Cabbage Maggot Fly, *Chortophila brassicæ*, has obtained a firm foothold in the northern states of the Union, and while in certain years it causes widespread and very serious damage, its constant presence demands persistent efforts at control. As in Britain, the damage is due to the burrowing of the maggots in the stems and roots of such plants as cabbages, cauliflower, turnips and radishes. The experimenters at the agricultural station associated with Cornell University have found that applications of corrosive sublimate or corrosive chloride of mercury—a well-known deadly poison—effectively check the maggots. The corrosive sublimate is used at a dilution of one ounce to eight gallons, and as the powder does not dissolve readily in cold water, hot water should be used in making up the solution. Two or three applications of this solution have been found to be effective, but with a weaker solution of one ounce to ten gallons, a weekly application made during the growth period of the plants has proved to be even more thorough in its action. The first application should be made within three or four days of the setting of the plants in the field, and the solution should be directed against the stems below the leaves, upon which the poison may have a caustic effect.

An Enemy of the Hessian Fly. *C. C. Hill in Journ. Agr. Research, Washington, Vol. XXV., 1923.*—Increasing importance is being attached to the checkmating of the insect pests of the farm by the encouragement of other insects which are parasitic upon them. Amongst these the subject of this paper, *Platygaster vernalis*, must be regarded as the most important insect enemy of the Hessian fly in the Middle Atlantic States. Observations upon its occurrence were consistently made from 1915 onwards, and an examination of 18,656 Hessian fly puparia has revealed the fact that no less than 23·89 per cent. of the spring generation were killed by this particular parasite; that is to say that for the spring generation it is more deadly to the Hessian fly than all its other insect parasites put together. Yet there is a fierce competition between the parasites themselves, and it is largely as a consequence of this that the death rate of *Platygaster vernalis* stands at over 81 per cent. in any one year. The author considers that, while the other parasites seriously discourage the multiplication of *Platygaster vernalis*, they largely supplement its efforts against the Hessian fly, so that a very high death rate is attained.

The Laws of Heredity and the Breeding of Farm Animals. *W. D. Hunt, New Zealand Journal of Agriculture, Vol. XXVII., No. 2, Wellington, 1923.*—The author draws attention to the importance of the stock breeder possessing marked ability in the selection of animals, as well as a knowledge of the laws of heredity.

The following is a brief record of results obtained by J. Gibson, the well-known Tasmanian breeder of Merino sheep, which are grown almost entirely for wool, the desire being to produce a sheep that would give the greatest amount of the best quality of wool. In 1868 he bred the ram Sir Thomas, the most noted Merino of his time; the heaviest fleece cut from this ram for twelve month's growth was 12 lbs. The descendants of Sir Thomas, given in order, gave fleeces of the following weights respectively:—14 lbs., 17 lbs., 18 lbs., 20 lbs., 26 lbs., 23 lbs., 27 lbs., 30 lbs., 36¾ lbs.

Thus, in a little over thirty years, by selecting those variations showing increased weight of wool, the weight was increased from 12 lbs. to 36¾ lbs., and this was done entirely within the flock without bringing in any outside blood.

The discoveries of Mendel serve to explain the reason for many results, as for example, the fact that red calves sometimes appear in pure herds of black Aberdeen-Angus cattle. Black and red are Mendelian characters, and black is dominant and red recessive, hence the result of crossing a black animal with a red would be a black animal, although such a calf would carry in its germ-cells the factor for red. From the above it will be seen that, before a red calf can appear in a black herd, both sire and dam must carry the factor for red; further, that if one animal were introduced into a herd which, although itself black, carried the factor for red, it would be possible in time for red animals to appear. The only way to make sure of keeping red out of a black herd is as follows:—

(*a*) Before introducing a new bull into a herd, test it with red or red-and-white cows. If the bull is a pure black all the calves will be black; if it carries the factor for red, about half the calves will be red.

(*b*) Note results from bulls bred in the herd when used in cross-bred herds. If any calves are red, the bull carries the red factor. If the sire of this bull has been proved pure, the red factor must have come from his dam, and the dam should be removed from the herd.

(*c*) If a red calf is born in a pure black herd, the sire and dam must both carry the red factor, and both should be removed from the herd.

Every breeder will be trying constantly to bring his flock or herd nearer to his ideal. In order to do this he can use sires of type and ancestry as near to his ideal as he can get them, or he can select with a view to correcting some weakness in his own animals—that is, if his animals have gone to an extreme in one direction, he can try to correct this by using sires that go to an extreme in the other direction.

The author considers that the first method is the best, as, although the second method may produce animals of satisfactory appearance, they will not breed true.

To breed true the animals must have uniform germ-cells, all carrying the same inheritance-factors. With an outcross there is always the danger of introducing germ-cells carrying the factor for some fault that may prove afterwards very difficult to eliminate, but experience has shown that animals which have been closely inbred for some time respond quickly to an outcross.

The above consideration brings up the question whether the best plan in a large stud is not to divide the stud into several families and closely to inbreed each within itself until weakness appears, then introduce a sire from one of the other inbred families, and continue the inbreeding until another outcross is required, when another family can be used.

Another important matter when establishing a stud is that of location. Animals can be altered by environment, and changes should all be in the direction of strengthening the type for the class of country in which they will live, or to which they will have to adapt themselves if sold. The location should be one where the conditions are such, that natural selection will

eliminate any individual unable to thrive under the conditions of the sires bred in the stud, where they are likely to be placed when sold.

Variations in Milk Yield. *J. Wilson, The Scientific Proceedings of the Royal Dublin Society, Vol. XVIII., New Series, Nos. 11-13, Dublin, 1922.*—VARIATIONS OF MILK YIELD WITH THE COW'S AGE AND LENGTH OF THE LACTATION PERIOD.—The author reviews in succession: (1) the records obtained from cows exhibited at the London Dairy Show, during the 10-12 years prior to 1909; (2) scale constructed by Gavin with reference to records kept in Lord Raylegh's dairy herds in Essex (England); (3) scales constructed by Pearl, Miner and Tocher based on records published by the Scottish Milk Records Committee relative to milk yields of Ayrshire cattle, 1903-1912. The author considers that scales based upon the Ayrshire records cannot represent the normal daily rise in milk yield, and bases his conclusions on the two foregoing records:—

(1) Suppose that at 8 years old the cow yields approximately 67-80-90-95-98 to 100, for 4-5-6-7 year old cows.
(2) Insufficient information is as yet available for 2-year-old yields, but those whose age averages about 2½ years should correspond to yields at 8-years-old, 50 to 100.
(3) For yields of cows over 8-years-old, records are also insufficient.

As regards milk yield during the lactation period, as the length of lactation varies, a scale is necessary to indicate how much should be added or subtracted to bring about a normal yield, *i.e.*, successive calving after 12 months according to the Ayrshire reports for 1920, a lactation period of 11 months, indicates an average of 38 weeks milk yield; a period of 12-13-14-15 months corresponds to 40-44-45-47 weeks yield respectively. Gavin found that the yields of cows which are in calf begin to decrease (below those of cows which are not calving) about 24 weeks before the next calves are born. For a lactation period of 11 months the yields should be about 20 gallons below that for normal lactation, and for 13-14-15 months' lactations, about 35, 65 and 90 gallons above that for normal lactation. The Ayrshire reports of 1913, 1919 and 1920 agree largely with the foregoing data.

Duration of the Gestation Period in English Pure-Bred Mares of Racing Stock. *Bédel, Revue de Zootechnie, Year 2, No. 4, Paris, 1923.*—After reference to the average length of the gestation period in pure-bred Persian, Arab and Russian mares, the author gives the results of his observations on the pure-bred English mare.

The average length of the gestation period in the case of the English mare is 348 days, with a maximum 387 and a minimum of 327 days. As a rule the gestation period is seven days longer for colts than for fillies. Its length is affected not only by causes depending on the mare and the sex of the offspring, but also by the sire's procreative power, which further influences the strength of the foal at birth.

On the other hand, the gestation period of some mares is habitually more protracted than that of others, and is usually shortest in small animals, although considerable differences in this respect have been observed between mares of the same size. Cases have been noted where the gestation period of mares four to six years of age has been two days shorter than in older animals. The number of foalings does not appear to exercise any marked effect.

Some mares seem to have inherited from their dams a predisposition to carry their foals for a longer or shorter time. The author is of opinion that the duration of the gestation period also varies according to the weather.

He noted that the number of colts or fillies among the foals sired by the same stallion was variable.

Controlling the Rations of Dairy Cows. *A. Leroy, Revue de Zootechnie, Year 2, No. 7, Paris, 1923.*—Good results have been obtained in the Department of Seine-et-Oise by the simultaneous control of the milk yield and the rations of dairy cows. The control service, which was instituted and is

directed by the Stocks-Breeding Committee (Comité d'élevage) of the district has been placed under the management of the Departmental Agricultural Office. The method adopted is extremely simple and consists in periodically weighing the cows and their daily ration. If this weighing is properly carried out, the work should be done in the same day as the milk is controlled, and can be done quickly and without a special staff, as approximate accuracy is sufficient for practical purposes. Having obtained these data, the controller is able, with the help of the existing tables giving the equivalent and percentage of the nitrogenous substances present in the various foods, to calculate feeding value and protein content of the ration. Since, on the other hand, he knows the average weight of cows and the average yield of milk per head, he is also in a position to calculate, with the help of the ration table, the feeding value and protein content of the ration that is theoretically necessary for dairy cows of the same weight and giving the same amount of milk. By this means it can be ascertained if the cows are being properly fed, or whether the food requirements of any animal necessitate a change in the ration.

The results obtained by this double control were then plotted on two graphic charts, three curves being drawn, showing respectively the effect of the ration on milk production, butter yield and live-weight. An examination of these charts shows the measures to be taken in every case, and especially as to how the diet should be changed.

According to the author, these three rules can be deduced from the charts.

(*a*) If the curves of milk yield, butter production and live-weight fall abruptly and are parallel, the ration must be increased.

(*b*) If the curves of milk yield and butter production fall slowly, while the curve of the live-weight remains horizontal, the cows are properly fed and no change should be made in the ration.

(*c*) If the curves of milk yield and butter production fall slowly, while the weight curve rises decidedly, the animals are receiving too much food, and the ration must be slightly reduced. In the last case, the tendency to put on fat which has already showed itself will hinder milk production. It is, however, necessary in interpreting the graphs to take into account any abnormal falls in the curves, as these are due to acute or chronic affections which are quite independent of the diet.

The Optimum Quantity of Skim Milk for Calf Feeding. *T. E. Woodward, Journal of Dairy Science, Vol. VI., No. 3, Baltimore*, 1923.—Feeding experiments were conducted at Beltsville, Maryland (U.S), with four groups of calves with four calves per group, balanced as nearly as possible with reference to breed and body weight at birth. Each calf received its mother's milk until it was ten day's old; the change to skim milk was made gradually during the following five days, and the feed was then an entirely skim milk ration. One group was given a daily ration at the rate of 1/7 body weight, two others at the rate of 1/6 and 1/8, and the fourth group was given all the milk the calves would drink twice a day. The experiment lasted seventy days. Records were kept as to gains in weight made by calves on various quantities of skim milk; at least 50 per cent. larger gains were noted for those receiving milk *ad. lib.* than for those fed at the rate of 1/7 their body weight. To do this they drank about 80 per cent. more skim milk, about 4/5 more than the first group. As regards the other two groups less satisfactory results were obtained, and it has been concluded that calves which received milk *ad. lib.* and at the rate of 1/7 made gains more economically than groups 1/6 and 1/8. In addition, feeding in large quantities did not cause scouring.

Potatoes in Pig-Feeding. *I.—Müller and Richter, Zeitschrift für Schweinezucht, Year 2, Part 3, Neudamm*, 1923. *II.—Idem, Ibidem, No.* 5.—I.—THE USE OF LARGE RATIONS OF POTATOES IN FATTENING PIGS.—Owing to the heavy potato crop produced in Germany in 1922, and the high price of barley, the question arose as to whether it was not possible entirely to suppress the cereal ration, and yet supply fattening pigs with sufficient protein.

The authors carried out some experiments in which they used nine pigs, five belonging to the native improved breed and four Yorkshires. The average age of the animals was twelve months. During the summer they had been turned out to graze, but had been given a small supplementary ration of concentrates. The pigs were fattened for six weeks from October 23, and received per head and per day: 200 gm. of fish-meal + 200 gm. dry beer-yeast + boiled, mashed potatoes *ad lib.* The fish-meal contained: crude protein, 46·4 per cent.; crude fat, 3·97 per cent.; salt, 9·4 per cent. The dry yeast contained 49·6 per cent. crude protein, the potatoes 12·2 per cent. starch. As the mixture was very liquid it was necessary, in order to prevent diarrhœa, to add 200 gm. chopped oat straw per head and per day. Initial weight 95 kg. Food consumed per head per day 14 to 18 kg., average 16 kg. Digestible protein ingested 292 gm. per head per day. The daily increase in live-weight was 799 gm., which was very satisfactory. In order to obtain 1 kg. increase in live-weight 19·72 kg. potatoes + 0·50 kg. fish-meal and beer-yeast were required, viz., 4·5 kg. of dry food.

It is thus quite possible and very economical to suppress all the barley-meal in the fattening ration of swine.

II.—SHOULD FATTENING SWINE BE GIVEN POTATOES? Owing to the high price of fuel, it seemed worth while trying whether pigs could not be fattened on raw potatoes. The authors carried out some experiments on thirty-six pigs of the ordinary breed, having an initial weight of about 55 kg., and which had been fed hitherto entirely on raw food. After a preliminary week of recuperation, the animals were given for five weeks, beginning from February 20, the following basal ration per head and per day: 700 gm. barley-meal + 150 gm. fish-meal + 150 gm. dry beer-yeast + 20 gm. washed lime. As a complementary ration they were fed *ad lib.*—*Lot* 1: steamed potatoes; *lot* 2: a mixture of $\frac{2}{3}$ boiled potatoes + $\frac{1}{3}$ raw potatoes; *lot* 3: mixture of $\frac{1}{3}$ boiled potatoes + $\frac{2}{3}$ raw potatoes; *lot* 4: raw potatoes. The pigs fed on the raw potatoes showed no signs of digestive disturbances, while in the others the slightly laxative action of the cooked potatoes was evident, and had to be corrected by the addition of a little chopped oat straw. Hence the solanin in the potatoes had no injurious effect. The cooked potatoes, however, were somewhat better assimilated, as was shown by the fact that the pigs receiving them increased daily in live-weight more than twice as much as the others, while consuming less food per unit of live-weight.

Destruction of the Fowl Mite. *W. M. Davidson, U.S. Dept. Agr., Dept. Bull. No.* 1228, *Jan.* 1924.—The reduction in condition caused by the presence on poultry of the red fowl mite (*Dermanyssus gallinæ*) and the consequent loss, have led to a thorough investigation of the means best suited for the destruction of the mite. During the night the mite attacks roosting poultry at all periods, except during the coldest season of the year. By day it hides in cracks and crevices, under roosts, or wherever shelter can be found, but sitting hens are liable to be attacked even during the day. As a result of many tests of multitudes of specifics recommended or advertised as effective in getting rid of mites, the experimenter came to the conclusion that fumigation of hen-houses is of little value, owing to the difficulty of making them sufficiently air-proof, nor does he favour the use of powders, such as calcium fluoride, sodium fluoride, Paris green, mercuric chloride, etc. Paints or sprays containing heavy coal tar oils were found most deadly, and the general recommendation is made that "heavy oils from coal tar and wood tar, or such oils diluted with a lighter oil, such as Kerosene, so that not less than 20 per cent. of the mixture is heavy oil, will successfully control chicken mites, provided the premises are thoroughly sprayed and the material not stinted. A heavy mineral oil emulsion, containing at least 20 per cent. oil in the actual spray, will be efficient under similar conditions.

The Nutritive Substances and Energy required by Laying Hens. *W. Völtz and W. Dietrich, Landwirtschaftliche Jahrbucher, Vol. LVIII., Part* 3, *Berlin*, 1923.—The experiments of the authors were made to determine the nutritive and energy requirements for egg-production, and also to

compare the relative value of dried beer-yeast and meat-meal as concentrated protein foods for fowls.

The experiments, in which thirty-five hens and five cocks of the Orpington breed were used, were divided into four periods, each of twenty-eight days. During one and three beer-yeast was fed, while meat-meal was given during two and four. Throughout all four periods the basal ration consisted of 32 per cent. rice, 32 per cent. barley, 25·7 per cent. potato flakes and 10·3 per cent. finely-chopped clover hay. During the yeast periods 32·1 gm. of yeast were added to every 100 gm. of the basal ration; 30·7 gm. of meat-meal being given during the other periods. The results of the analyses are set out in thirty-five tables. The table that gives the relative utilisation of the energy and the digestible crude proteins present in the food shows that from the standpoint of egg-production beer-yeast is at least as good as meat-meal, when the rations contain equal quantities of digestible and available nutrient substances.

It was found that an Orpington hen of the average weight of 2·4 kg. and laying in round numbers every other day one egg weighing 58 gm., requires a total of 146 available calories per head and per day. On an average 27 per cent. of the available nutrient substances at the hen's disposal for egg-production were found in the egg, and only 11·3 per cent. of the available ingested nutrient substances were used in its formation. Further, on an average only 22 per cent. of the available protein was employed in egg-production. Thus, in comparison with the return of other domestic animals, that of the hen is very low (15-20 per cent. of the available nutrient substances and 45·7 per cent. of those at disposal for production pass into the milk of the cow, 33 per cent. of the available nutrients go into the meat of cattle and sheep, and 45 per cent. into that of young pigs). Under the present conditions of fowl-rearing, however, birds allowed their liberty pick up a lot of food that costs nothing, and could not be used in any other manner.

The average weight of the eggs, their percentage of white, yolk and shell, together with their chemical composition varied little, if at all, during the different experiment periods. Sexual excitement or its absence, that is to say the presence or absence of the male bird, had no effect upon either the weight or the number of the eggs produced.

Milk for Young Chicks. *F. Delmas (Directeur du Centre avicole de l'Officee départemental des Bouches du Rhône), La Vie agricole et rurale, Vol. XXIII., No.* 30, *Paris*, 1923.—With the object of ascertaining whether giving milk to young chicks would prevent the great losses that frequently occur in very young broods, especially when they belong to Mediterranean breeds, the author made experiments on forty-two Leghorn chickens (of the white and brown varieties) that had been hatched on the same day. The chickens were divided into two lots each of twenty-one birds. The first lot was given milk with the addition of one-third water and weighed 987 gm., while the second had only water to drink and weighed 994 gm. Both lots were otherwise fed exactly alike. The chicks drank the milk and water with avidity. The experiment was continued for two months and the results obtained were indisputable; in the first lot only two chicks died, whereas the number of deaths in the second lot was six.

These results were confirmed by experiments conducted on vitamines, for if vitamine A (antirachitis) is deficient in the food ration of chicks, it should be introduced into the average ration, even if the ration contains sufficient vitamine B (antineuritic) from the liberal grain supply, and also plenty of vitamine C (antiscorbutic), which can be obtained from green food.

Effect on Egg Production of Artificial Lighting of Poultry Houses in Winter. *G. Denis, La Revue Avicole, Year* 33, *No.* 3, *Paris*, 1923.—During the winter 1921-1922, the author used to shut up his hens in the fowl-house as soon as it became dark, but he turned on the light from 9.30 P.M. to 10 P.M. and supplied the birds with food and water. As the arrangement gave good results, he repeated the experiment during the following winter with one important modification. The fowls were shut up when it became dark,

but the hen-house was lighted from the time of their return until 10 P.M. Very small grain, barley and oats, and especially millet were scattered on the ground amongst the straw and sawdust, and at 9 P.M. the birds were given a grain different from that fed them during the day. The fowls had a liberal and varied diet: black oats, buckwheat, barley and oats, millet and a mixture (maize, hemp-seed and sunflower seeds), as well as paste every day early in the morning, and household scraps with the addition of a little fish-meal or meat-meal and powdered oyster-shells at 11 o'clock. Ten days after this régime was started the birds' combs became of a brighter red and they regained their lively gait. By 1st November a large number of the hens were already laying; on the 15th almost all were producing eggs, and on the 20th, out of the 115 fowls belonging to the various breeds which included White and Buff Wyandotte, White and Buff Leghorn, Black La Bresse and Bourbonnais, there was not a single hen that was not laying.

The author estimates that without the use of artificial light only twenty to twenty-five of the hens would have been laying, and their egg production would have been much more irregular. The increased egg supply obtained would thus appear to be due to the influence of the light, which by shortening the hours of darkness not only allowed the fowls to lay until 10 o'clock at night, but also made it possible for them to take in the store of food needed for the production of a large number of eggs.

Observations on the Number and Weight of Hens' Eggs. *R. Lienhart, Comptes rendus des Séances de la Société de Biologie, Vol. LXXXVIII., No.* 14, *Paris*, 1923.—The author's remarks refer to fowls kept in enclosed runs and fed on a ration of constant nutritive value. The facts noted were the same in the case of the Black Bresse, Leghorn, Minorca, Houdan and Faverolle breeds respectively.

Ten La Bresse hens laid altogether 1150 eggs during their first year, 800 in the second, 570 in the third, 265 in the fourth, and 83 in the sixth. The average weight of the eggs was 45 gm. the first year, 59 the second and 60 the succeeding years. Hence (1) under normal conditions of feeding, hens produce most eggs the first year of laying; (2) two-year-old fowls that lay larger eggs need more intensive feeding; (3) the number of eggs laid the first year can only be increased by liberal and systematic feeding; (4) two-year-old hens must be chosen for sitting, since they have the greatest vitality; (5) in order to carry out the selection of sexes by means of the author's method, it is necessary to take eggs laid by hens of the same breed and also of the same age, because the average weight of the egg produced by a hen of the same breed varies according to the age of the bird.

Cleaning Apparatus used in Machine Milking. *H. Burgwald (Assistant Market Milk Specialist), U.S. Department of Agriculture, Farmers' Bulletin No.* 1315, *Washington, D.C.*, 1923.—The Department of Agriculture of the United States has instituted a series of experiments in the sterilisation of apparatus used in machine milking. Heat is the safest and simplest means of sterilisation, the effect of which has chiefly been studied with reference to apparatus working in a vacuum, but the same principle could be applied with some small differences to other types.

The comparative bacterial counts made in the case of apparatus sterilised with a solution of chloride of lime and with heat respectively have been favourable to the latter method. The average number of bacteria per cc. found in milk samples taken at thirteen farms where other methods were employed was 257,900, whereas in the case of farms where sterilisation by heat was practised the average number of bacteria present was only 19,300 per cc. (the average age of the samples at the time the count was made was twelve hours).

The rubber portions of the apparatus were but little, if at all, more affected by the temperatures employed (71° C. to 72° C.) than when recourse was had to other methods of sterilisation. The rubber must, however, be cleaned carefully before the heat is applied, for fatty substances exert an injurious effect at these temperatnres.

The various operations of the process are explained by a series of diagrams.

Immediately after milking, the apparatus is rinsed in hot water (which is in all cases sucked up by a vacuum system), ten to twelve times in succession. It is then rinsed with water in which some cleansing substance has been dissolved, rinsed again, and subsequently immersed in water raised by steam to 71° to 72° C., and kept at this temperature for fifteen to thirty minutes. If no steam for heating is at disposal, it is best not to immerse the rubber portions until the heating is finished, in order to prevent their coming in contact with the wall of the heated receptacle. The vacuum tube ought to be cleaned every fortnight by the passage of hot water. The pails and covers should be sterilised with steam by preference, or else by means of immersion for five minutes in boiling water.

The Production of Bees and the Age of their Queen. *F. Brünnich (Bezirkslehrer, Kaiserstuhl), Schweizerische Bienen-Zeitung, Year* 46, *No.* 5, *Aaren*, 1923.—It has been stated that queen bees are only in full vigour during the first year of their life, and that in order to have efficient hives of bees they must have a new queen annually.

Prof. Brünnich, the father of the author, has tested the truth of this statement experimentally by determining every year from 1908 to 1921, the amount of honey (supply left in the hive + amount taken) made by: 111 hives of bees with a queen one year of age; 61 with a two-year-old queen; 41 with a three-year-old queen and 10 with a four-year-old queen. The results thus obtained (published in the *Archiv für Bienenkunde*, Part 4, 1922) show that a queen two years of age proved the best almost every year.

Cleaning Aluminium Dairy Utensils. *E. Drouilly, Directeur du département d'Aluminium à la Société des Tréfileries et Laminoire du Havre. Le Lait, Year* 3, *No.* 2, *Lyons*, 1923.—In order to give aluminium pans a new appearance it is only necessary to proceed as follows:—Immerse them for some seconds in a bath of 10 per cent. boiling caustic soda, wash them in running water, and put them for five minutes in a cold 10 per cent. acqueous solution of nitric acid, wash them over with a soft rag in order to remove the sodium nitrate that has formed, wash them again to remove any nitric acid present and then dry the pans. The drying method most commonly adopted is to dip the pans into boiling water and leave them to drain. This process must, however, only be carried out at long intervals in dairies, for it has the disadvantage of reducing the thickness of the metal about $\frac{1}{100}$ of a mm. for every minute of immersion in the bath of 10 per cent. caustic soda heated to 100° C.

As a rule, cold carbonate of soda which has hardly any effect upon aluminium is employed in dairies, but fairly warm solutions are to be recommended for detaching the particles of dried milk and the fatty matter. As this solution may attack the aluminium in the course of time, sodium silicate to the amount of 25 per cent. of the weight of the sodium carbonate should be added to a bath of sodium carbonate of the temperature of 75° C.; if the temperature of the bath is 100° C., the amount of silicate may be a little increased, whereas if it is only 30° C., it suffices to add a weight of sodium silicate equal to 10 per cent. of the weight of the sodium carbonate.

Apparatus for Drying Hay without Sunshine. *The Engineer, Vol. CXXXVI., No.* 3523, *London* 1923.—Mr R. B. Matthews, M.I.E.E., exhibits an apparatus which he claimed would render agriculturists independent of sunshine for drying their hay. The hay is made up into a conical heap and dried by means of a strong current of air directed from the base to the top by means of a ventilator. This treatment is discontinued after some hours, and as the heat increases, bacterial and chemical action begin. The bottom of the cock first commences to heat up and reaches a sufficient temperature after twenty-four hours. The aeration is repeated and is succeeded by an interval of repose, during which a new layer of hay attains the degree of heat required. This process is repeated until the whole heap has been acted upon in the same manner. The inventor states that hay thus made is superior in quality to the ordinary product, and that, in spite of the expense of transporting a large

amount of fresh grass, the net cost is lower, because the usual operations of hay-making are not required.

The World's Production of Eggs.—The United States have broken the record for egg-production. There are in that country 233,832,546 hens, which are said to have laid 14,620,000,000 eggs, but if the number of eggs produced by each fowl is taken into account, it is by no means large, being only 64. Germany registers 52,270,000 fowls and 4,590,000,000 eggs, with an average of 82 eggs per hen. England possesses 25,120,000 hens laying 2,125,000,000 eggs, average 86 per hen, France has 15,000,000 hens, Denmark has 14,055,000 hens producing 935,000,000 eggs, average per hen 84, and Belgium possesses 503,000 hens laying 510,000,000 eggs; average per hen 92 eggs.

System of Protection against Frost. *The Implement and Machinery Review.*—In connection with the note which appeared in the last issue under this heading, a correspondent writes to say that in America and Canada it has been recently discovered that the cheapest, most convenient, and most efficient non-freezing cooling fluid for radiators is a mixture of honey and water. For the very low temperatures common in the northern States and Canada the mixture recommended is fifty-fifty, but a much smaller proportion of honey would be sufficient in our climate. The poorest grade of honey is just as efficient as the more expensive kinds, and the honey never needs to be renewed, since it is only the water that evaporates. It is found also that the mixture does not boil at such a low temperature as does water.

OFFICIAL ORDERS AND CIRCULARS.

THE following was issued recently by the Board :—

Official Immunity Trials.

Wart Disease of Potatoes.

The Board of Agriculture for Scotland announce that they are now making arrangements for the continuance during the coming season of the trials conducted by them for the testing of new varieties of potates for immunity from wart disease.

Growers and merchants who have stocks of new varieties which they desire to have tested for this purpose should forward samples by post to the director ot the Plant Registration Station, East Craigs, Corstorphine, to arrive not later than 15th March. A note of the name or reference number allotted to the variety and an indication of its date of maturity should be enclosed with each sample. When more than one sample is forwarded, each sample should be contained in a separate parcel. Each sample should consist of not less than forty-two sound seed tubers weighing approximately 7 lbs.

A fee of 5s. will be chargeable in respect of each sample forwarded for inclusion in the trials. This fee will cover the testing of a sample for the full period necessary to determine its susceptibility to, or immunity from, wart disease. No certificate of immunity will be issued in respect of any new variety included in the trials, unless it has been tested for at least two successive years, and in both seasons is found to be unaffected by wart disease. The immunity trials will be carried out at the Board's Wart Disease Testing Station, but, in addition, portions of the samples of the varieties received for test will be planted at the Board's Plant Registration Station, where observations will be made on their botanical characters by the Potato Synonym Committee with a view to determining whether they are of distinct type or identical with existing standard types.

It has been decided that the Agricultural Departments concerned should issue each year a uniform list of immune varieties of potatoes approved for planting in Scotland, England and Wales and Northern Ireland respectively. In order that the testing of new varieties may be conducted under varying

conditions of soil and climate, arrangements have accordingly been made for the second and, if necessary, subsequent year's trials being carried out simultaneously at each of the three national stations. Growers who submit samples of varieties for inclusion in this year's trials should, therefore, note that they will be required to submit next season a certain number of tubers from their stocks of these varieties for the second year's trials at the Board's station and at the other national stations.

Single Tuber Tests.—Subsidiary to the main trials outlined above, there are provided free of charge by the Board facilities for testing single tubers of seedlings. This test is designed to enable potato breeders to discard at an early stage varieties which are susceptible to wart disease. The test is limited to seedlings in the first or second year of their existence from true seed from the potato berry or seed ball.

A statement that the tubers submitted fulfil this condition must accompany each consignment. In general, not less than twenty seedling tubers will be accepted from any one breeder, one tuber only of each seedling being required. Each tuber should have distinctly marked on it with Indian ink a reference number by which the sender can identify his stock. The reference numbers of any series should be consecutive. All samples for the single tuber test should reach the director of the registration station not later than 15th March.

Identity Tests.—In addition to the immunity tests, the Board are prepared to undertake the testing of samples of potatoes for the purpose of determining their variety. Samples submitted for testing for this purpose should consist of not less than 12 (twelve) tubers. The fee for this test will be 5s. per sample.

Stock Tests for Purity, &c.—Facilities will also be afforded for the testing of samples of merchants' or farmers' stocks with a view to furnishing a report on their purity and immunity from wart disease. Such samples should be forwarded by rail to East Craigs, Corstorphine (L. & N. E. R.), in lots of 28 lbs., and a fee of £1, 1s. will be chargeable for the testing of each sample.

NOTE.—*Intimation of the despatch of samples, together with the amount of fees payable should be sent to the Secretary, Board of Agriculture of Scotland, York Buildings, Queen Street, Edinburgh, at the same time that the samples are forwarded to the Director of the Plant Registration Station at Corstorphine.*

STATISTICS.

PRICES of AGRICULTURAL PRODUCE and FEEDING STUFFS in December 1923 and January and February 1924.

AVERAGE PRICES OF LIVE STOCK IN SCOTLAND.

(Compiled from Reports received from the Board's Market Reporters.)

Description.	December. 1st.	December. 2nd.	December. 3rd.	January. 1st.	January. 2nd.	January. 3rd.	February. 1st.	February. 2nd.	February. 3rd.
FAT STOCK :—									
CATTLE—	per cwt. l.w. s. d.	per cwt. l.w. s. d.	per cwt. l.w. s. d.	per cwt. l.w. s. d.	per cwt. l.w. s. d.	per cwt. l.w. s. d.	per cwt. l.w. s. d.	per cwt. l.w. s. d.	per cwt. l.w. s. d.
Aberdeen-Angus ...	71 5	65 7	42 9	69 7	64 3	42 6	67 3	62 0	42 11
Cross-bred (Shorthorn)	66 1	59 7	38 0	65 11	59 7	38 4	63 10	58 6	38 10
Galloway	64 2	58 0	38 0	63 11	58 5	..	62 8	57 6	...
Ayrshire	63 6	50 9	36 8	62 2	49 7	39 6	56 0	43 0	35 0
Blue Grey	...	...	...	...	...	...	...	...	...
Highland	...	...	...	...	...	...	...	...	...
	per lb. d.	per lb. d.	per lb. d.	per lb. d.	per lb. d.	per lb. d.	per lb. d.	per lb. d.	per lb. d.
VEAL CALVES	18	10	7	17¾	8½	6¼	17	7½	6
SHEEP—	under 60 lb. per lb. d.	60 lb. and upw'ds. per lb. d.	Ewes per lb. d.	under 60 lb. per lb. d.	60 lb. and upw'ds. per lb. d.	Ewes per lb. d.	under 60 lb. per lb. d.	60 lb. and upw'ds. per lb. d.	Ewes per lb. d.
Cheviot	16¼	15¼	11¾	16¾	15½	12	16½	15	12½
Half-bred	16¼	15	11¼	16¾	15½	11½	16½	15¼	11¾
Blackface	16¾	15¼	11¼	17	15½	11½	17¼	15¼	11½
Greyface	16¾	15¼	10¼	17¼	15¾	10¼	16¾	15½	9¾
Down Cross	16½	15¼	...	16¾	15¼	...	16½	15½	...
PIGS—	per stone. s. d.	per stone. s. d.	per stone. s. d.	per stone. s. d.	per stone. s. d.	per stone. s. d.	per stone. s. d.	per stone. s. d.	per stone. s. d.
Bacon Pigs	11 5	9 11	9 5	11 1	9 9	8 10	10 2	8 11	7 10
Porkers	11 9	10 6	10 0	11 5	10 2	8 10	10 8	9 4	..

AVERAGE PRICES OF LIVE STOCK IN SCOTLAND—*continued.*

Description.	December. 1st.	December. 2nd.	December. 3rd.	January. 1st.	January. 2nd.	January. 3rd.	February. 1st.	February. 2nd.	February. 3rd.
STORE STOCK :—									
STORE CATTLE—	per head.	per head.	per head.	per head.	per head.	per head.	per head.	per head.	per head.
Aberdeen-Angus :	£ s.	£ s.	£ s.	£ s.	£ s.	£ s.	£ s.	£ s.	£ s.
Yearlings	20 2	16 0	14 0	18 1	15 8	14 0	18 17	15 7	13 10
Two-year-olds ...	26 17	22 3	...	27 13	22 6	...	28 2	23 16	22 0
Cross-bred (Shorthorn) :									
Yearlings	18 2	14 8	12 13	17 18	14 11	12 10	18 9	14 16	11 15
Two-year-olds ...	26 0	20 18	...	25 17	20 14	15 0	26 10	21 4	17 5
Galloway:									
Yearlings	...	...	...	...	...	...	13 0	.	...
Two-year-olds ...	22 0	...	...	...	...	...	20 15	...	.
Ayrshire :									
Yearlings	...	...	...	...	...	...	...	...	...
Two-year-olds ...	...	...	...	...	...	...	...	...	..
Blue Grey :									
Yearlings	...	...	...	...	...	..	.	...	...
Two year-olds ...	...	...	..	.	...	...	...	...	..
Highland :									
Yearlings . ..	13 10	10 0	...	...	...	...	15 0	9 13	7 8
Two-year-olds ...	...	...	...	...	...	...	15 8	..	...
Three-year-olds ...	...	...	...	...	...	...	22 10	18 8	...
DAIRY COWS—									
Ayrshire :									
In Milk	...	26 0	12 0	28 10	22 16	12 4	36 0	27 5	22 3
Calvers	30 5	23 13	15 5	31 9	24 4	15 6	34 14	25 16	20 0
Shorthorn Crosses :									
In Milk	38 3	25 0	12 6	43 12	28 12	17 3	40 18	32 9	22 0
Calvers	35 7	27 11	18 15	35 17	28 5	20 13	37 2	28 17	21 1
STORE SHEEP—	*s. d.*	*s. d.*	*s. d.*	*s. d.*	*s. d.*	*s. d.*	*s. d.*	*s. d.*	*s. d.*
Cheviot Hoggs ...	...	...	...	49 8	...	...	62 6	43 4	35 0
Half-bred Hoggs ...	...	...	...	75 4	66 5	50 2	80 1	59 8	45 6
Blackface Hoggs ...	...	.	..	43 6	31 0	...	44 4	34 9	24 6
Greyface Hoggs ...	...	...	...	68 7	57 0	...	66 6	56 0	46 9
STORE PIGS—									
(6 to 10 weeks old)	31 0	21 9	...	33 8	20 9	...	32 4	18 4	...

VERAGE PRICES OF DEAD MEAT AT DUNDEE, EDINBURGH, AND GLASGOW.

(*Compiled from Reports received from the Board's Market Reporters.*)

Description.	Quality.	December.			January.			February.		
		Dundee.	Edinburgh.	Glasgow.	Dundee.	Edinburgh.	Glasgow.	Dundee.	Edinburgh.	Glasgow.
		per lb. d.	per lb. d.	per lb. d.	per lb. d.	per lb. d.	per lb. d.	per lb. d.	per lb. d.	per lb. d.
BEEF:—Home-fed—										
Bullock or Heifer ..	1	10⅝	10¼	11¾	10⅜	10½	11¾	10¼	10¼	11¾
	2	10	8½	9⅞	10⅛	8⅞	9⅞	10	9⅛	10⅛
Bull	1	8	7¾	8⅛	8¼	8¼	7¾	8¼	8¾	8⅝
	2	7⅜	6⅝	7⅛	7¾	7¼	6⅞	7¾	8	6⅞
Cow	1	6⅞	6¼	7	7	6¾	7½	7⅛	6⅞	8¼
	2	6½	5⅝	6	6½	6	6½	6⅝	6	6½
Irish—Bullock or Heifer	1	..	8⅝	8¼	..	...	9¼	...	...	10⅛
	2	...	7¼	7½	...	...	8¾	...	...	9
Bull	1	...	...	6⅝	...	...	6¼	...	...	7⅝
	2	...	...	5⅞	...	...	5½	...	...	6⅛
United States & Canadian—										
Killed at Birkenhead	1	...	..	7¾	...	...	..	...	..	..
	2	..	...	7¼	...	.	...	...	...	.
,, Glasgow ...	1	...	..	7½	..	...	8⅝	...	...	9
	2	...	..	7	..	...	7⅞	...	.	8½
Argentine Frozen—										
Hind Quarters ...	1	...	5⅝	5¾	...	5½	5¼	...	6⅞	6
Fore ,, ...	1	...	4¼	4	..	4¼	4⅛	...	5¼	5¼
Argentine Chilled—										
Hind Quarters ...	1	...	6½	6	..	6¼	6¼	...	7⅛	7
	2	...	..	5⅝	.	...	5½	...	...	6⅛
Fore ,, ...	1	...	4⅜	4¼	...	4⅜	4⅜	...	5⅛	5⅛
	2	...	...	4	.	...	...	...	...	4½
Australian Frozen—										
Hind Quarters ...	1	...	...	5½	...	...	5	...	...	5½
	2	...	...	4⅞	...	...	4¾	..	...	...
Fore ,, ...	1	...	...	3¾	...	..	...	..	...	5¼
	2	...	...	...	...	...	...	...	...	...
New Zealand Frozen—										
Hind Quarters ...	1	...	...	5½	...	...	...	...	...	...
	2	...	...	..	...	...	..	...	...	...
Fore ,, ...	1	...	...	...	...	...	...	...	..	...
	2	...	...	...	...	...	...	...	...	...
MUTTON:—										
Hoggs, Blackface ...	under 60 lb.	16½	13⅝	14⅛	17⅜	13¾	14⅛	14⅞	13¼	14⅞
	60 lb. & over	...	12⅛	13¼	17	12⅝	13	...	12¼	13⅛
,, Cross	under 60 lb.	16½	14¼	14⅞	17⅝	14⅜	15¼	14⅞	13⅝	14⅞
	60 lb. & over	...	12⅝	14	17	12⅞	14¼	...	11⅞	13⅞
Ewes, Cheviot ...	1	10⅞	9⅝	10¾	11¼	9⅝	11⅛	10¾	9¾	11
	2	...	...	9½	11	...	10⅛	10	...	9⅞
,, Blackface ...	1	10⅞	...	9¾	11¼	8¼	10½	10¾	...	10½
	2	...	...	8⅞	11	...	9¾	10	...	8⅞
,, Cross	1	8⅝	8½	8⅞	9¼	9⅛	9¼	8⅛	9	9
	2	...	...	8⅛	8	...	8¾	7¾	...	8¼
Argentine Frozen ...	1	...	7¼	7	..	7¾	7¼	...	8¼	8
	2	...	...	...	...	7¼	...	...	...	...
Australian ,, ...	1	..	...	6¼	...	...	6¼	...	...	7⅛
	2	...	...	6	...	...	6	...	...	...
New Zealand ,, ...	1	...	...	...	...	...	...	...	...	...
	2	...	...	...	...	...	...	...	...	...
LAMB:—Home-fed ...	1	...	...	15	...	...	...	...	...	...
	2	...	...	13	...	...	...	...	...	...
New Zealand Frozen	1	...	11½	11	...	12	11	...	11⅞	11⅛
	2	...	...	9½	...	...	9½	...	...	...
Australian ,, ...	1	...	...	9	...	...	9¼	...	...	10½
	2	...	...	8	...	...	8	...	...	...
Argentine ,, ...	1	...	9¼	...	...	9¾	...	...	9⅞	...

AVERAGE PRICES OF PROVISIONS AT GLASGOW.

(Compiled from Reports received from the Board's Market Reporters.)

Description.	Quality.	December. s. d.	January. s. d.	February. s. d.
BUTTER:				
Irish Creamery... per cwt.	1	215 4	...	...
,, ,, (Unsalted) ,,	1	225 4	...	...
Danish ... ... ,,	1	228 0	228 4	224 11
,, (Unsalted) ,,	1	237 6	238 4	234 11
New Zealand ... ... ,,	1	224 0	222 10	213 9
CHEESE: Cheddar ... ,,	1	134 0	131 7	126 6
	2	130 0	127 7	122 6
Dunlop ... ... ,,	1	124 0	121 7	120 6
	2	121 0	118 7	117 3
Canadian ... ... ,,	1	116 9	113 5	109 0
New Zealand (Coloured) ,,	1	118 6	113 5	108 9
New Zealand (White) ,,	1	116 9	112 5	108 9
BACON:				
Ayrshire (Rolled) ... ,,	1	132 6	138 5	138 6
Irish (Green) ... ... ,,	1	103 0	...	...
,, (Dried or Smoked) ,,	1	126 0	130 0	122 9
,, (Long Clear) ... ,,	1	108 6	109 2	104 6
Wiltshire (Green) ... ,,	1	94 0	101 2	...
,, (Dried or Smoked) ,,	1	115 4	124 2	...
American, Long Clear Middles (Green) ,,	1	77 0	72 0	70 0
American, Short Clear Backs ... ... ,,	1	88 0	83 2	81 0
American, Bellies... ,,	1	91 0	90 0	88 0
,, Sides ... ,,	1	...	...	...
,, Cumberland Cut ,,	1	70 0	68 2	68 0
Canadian, Sides ... ,,	1	80 6	86 5	82 9
Danish, Sides ... ,,	1	95 0	99 7	96 0
HAMS:				
Irish (Smoked) per cwt.	1	146 0	140 10	137 6
American, Long Cut (Green) ... ... ,,	1	97 0	89 7	83 0
American, Short Cut ,,	1	94 0	94 10	91 0
Canadian, Long Cut ,,	1	100 0	94 0	...

Description.	Quality.	December. s. d.	January. s. d.	February. s. d.
EGGS:				
Country ... ... per doz.	1	3 8	3 3	2 6
	2	3 7	3 1	2 4
Irish ... ... per 120	1	33 3	29 0	22 8
	2	31 9	27 11	21 8
,, (Cold Stored) ,,	1	19 0	19 4	...
	2	18 0	...	...
,, (Duck) ... ,,	1	25 0	26 8	24 4
	2	...	...	...
American ... ... ,,	1	18 2	20 0	18 6
	2	...	19 0	...
Argentine ... ... ,,	1	19 8	20 0	...
	2	18 9	19 0	...
Canadian .. ... ,,	1	21 8	21 4	20 0
	2	20 8	21 0	...
Chinese ... ... ,,	1	...	18 4	17 3
	2	...	16 6	16 0
Danish ... ... ,,	1	32 0	32 4	23 5
	2	30 8	30 0	22 0
Dutch ... ... ,,	1	27 2	...	20 0
	2	27 0	...	...
Dutch (Duck) ... ,,	1	20 0	..	...
Egyptian ... ... ,,	1	12 6	12 11	13 5
	2	12 0	12 2	12 3
Italian (Turkey) ... ,,	1	30 4	29 2	...
Moroccan ... ,,	1	...	18 0	17 9
Polish ... ... ,,	1	16 0	...	...
	2	15 0	...	...
Russian .. ... ,,	1	17 11	20 0	...
	2	17 0	19 0	...

AVERAGE PRICES OF POTATOES AT DUNDEE, EDINBURGH, AND GLASGOW.

(*Compiled from Reports received from the Board's Market Reporters.*)

Markets.	Quality.	Late Varieties. Red Soils. Langworthy and Golden Wonder.	Red Soils. Other.	Other Soils. Langworthy and Golden Wonder.	Other Soils. Other.
		per ton. £ s. d.	per ton. £ s. d.	per ton. £ s. d.	per ton. £ s. d.
DECEMBER.					
Dundee	First	...	...	...	6 0 0
	Second	...	...	...	..
Edinburgh	First	...	...	8 10 0	6 11 0
	Second	...	...	...	...
Glasgow	First	11 3 0	8 3 0	8 17 0	7 10 0*
	First	...	...	...	6 18 0†
	Second	...	...	...	...
JANUARY.					
Dundee	First	...	...	10 10 0	8 0 0
	Second	...	...	...	...
Edinburgh	First	10 8 0	...	11 5 0	9 19 0
	Second	...	...	...	...
Glasgow	First	12 5 0	10 4 0	11 5 0	9 17 0*
	First	...	...	...	9 4 0†
	Second	...	...	...	...
FEBRUARY.					
Dundee	First	...	...	12 0 0	10 5 0
	Second	...	...	...	9 10 0
Edinburgh	First	...	...	...	11 0 0
	Second	...	...	...	...
Glasgow	First	14 3 0	11 12 0	12 17 0	10 17 0
	Second	...	...	...	...

* Kerr's Pink. † Arran Chief.

AVERAGE PRICES OF ROOTS, HAY, STRAW, AND MOSS LITTER, AT DUNDEE, EDINBURGH, AND GLASGOW.

(*Compiled from Reports received from the Board's Market Reporters.*)

Markets.	Quality.	Roots. Carrots.	Roots. Yellow Turnips.	Roots. Swedes.	Hay. Rye Grass and Clover.	Hay. Timothy.	Straw. Wheat.	Straw. Barley.	Straw. Oat.	Moss Litter.
		per ton. s. d.	per ton. s. d.	per ton s. d.	per ton. s. d.	per ton. s. d.	per ton. s. d.	per ton s. d.	per ton. s. d.	per ton. s. d.
DECEMBER.										
† Dundee ...	1	...	13 0	19 3	118 9	...	87 6	...	93 9	...
	2	...	...	18 0	112 6	...	...	...	...	...
‡ Edinburgh	1	...	...	22 6	105 8	...	53 9	...	68 2	...
	2	...	...	...	80 10	...	...	...	...	...
Glasgow...	1	...	...	...	...	...	...	...	...	33 9
	2	...	...	...	...	...	...	...	...	...
JANUARY.										
† Dundee ...	1	...	15 0	18 2	129 0	...	91 0	...	94 6	...
	2	...	...	...	...	...	...	...	...	...
‡ Edinburgh	1	...	...	...	118 2	...	62 6	65 0	80 8	...
	2	...	...	...	...	...	...	...	...	...
Glasgow...	1	...	...	...	...	...	...	...	...	38 6
	2	...	...	...	...	...	...	...	...	...
FEBRUARY.										
† Dundee ...	1	...	15 0	16 6	137 6	...	94 5	93 4	94 5	...
	2	...	...	...	132 6	...	...	...	...	...
‡ Edinburgh	1	...	...	...	115 0	...	64 5	61 8	73 9	...
	2	...	...	...	...	...	...	...	...	...
Glasgow...	1	...	...	...	...	...	...	...	...	40 0
	2	...	...	...	...	...	...	...	...	...

† Quotations for Hay and Straw, baled and delivered.
‡ „ „ „ delivered loose in town.

AVERAGE PRICES OF FEEDING STUFFS AT GLASGOW AND LEITH.

(Compiled from Reports received from the Board's Market Reporters.)

Description.	December.		January.		February.	
	Glasgow.	Leith.	Glasgow.	Leith.	Glasgow.	Leith.
	per ton. £ s. d.	per ton £ s. d.	per ton. £ s. d.	per ton. £ s. d.	per ton. £ s. d.	per ton. £ s. d.
Linseed Cake—						
Home	14 5 0	13 15 0	14 5 0	13 11 0	14 1 8	13 3 9
Foreign	12 13 2	13 0 0	12 15 0	13 0 0	13 2 6	12 15 0
Soya Bean Cake	...	...	11 13 4	...	11 15 0	...
Undecorticated Cotton Cake—						
Bombay (Home-manufactured)	7 13 9	7 5 0	7 17 0	7 8 0	7 17 6	7 6 3
Egyptian (Home-manufactured)	8 8 9	...	8 10 0	...	9 1 11	...
Coconut Cake ...	9 2 6	...	9 13 2	...	9 11 3	...
Palmnut Kernel Cake	8 1 3	...	8 7 0	...	8 10 0	...
Groundnut Cake—						
Undecorticated ...	*9 1 3	*9 5 0	*9 13 0	...	*9 10 0	...
Maize Germ Cake	11 5 0	...	11 5 0	...	11 5 10	...
Maize Germ Cake Meal	11 12 6	...	11 12 6	...	11 13 9	...
Bean Meal ...	11 8 9	11 15 0	11 10 0	11 15 0	11 17 6	11 15 0
Maize Meal ...	9 16 3	9 7 6	10 7 0	10 5 0	11 10 0	11 0 0
Locust Bean Meal	...	7 10 0	...	7 10 0	...	7 10 0
Rice Meal... ...	7 5 0	...	7 8 4	...	7 10 0	...
Locust Beans (Kibbled & Stoned)	...	6 10 0	...	6 10 0	...	6 10 0
Maize Gluten Feed (Paisley)	9 5 0	...	9 6 0	...	9 13 9	...
Maize	†9 15 0	9 5 0	‡10 2 6	10 0 0	‡10 15 0	10 10 0
Oats, Canadian ...	9 6 3	...	9 1 0	...	8 19 5	...
„ Home ...	9 10 0	9 0 0	9 13 0	9 0 0	10 0 0	9 0 0
Barley (Feeding) ...	9 8 9	8 5 0	9 15 0	9 5 0	10 7 6	9 15 0
Malt Culms ...	7 3 9	...	7 4 0	...	7 6 3	...
Distillery Mixed Grains—Dried ...	...	8 10 0	...	8 10 0	...	8 10 0
„ Wet ...	...	1 15 0	...	1 15 0	...	1 15 0
Brewers' Grains—						
Dried	7 15 0	7 5 0	7 13 4	7 5 0	8 0 0	7 5 0
Wet	...	1 12 6	...	1 12 6	...	1 12 6
Distillery Malt Grains Dried ...	8 0 0	...	8 0 0	...	8 6 11	...
Wheat—						
Middlings (Fine Thirds or Parings)	10 5 0	9 7 6	10 2 0	9 10 0	10 0 0	9 10 0
Sharps (Common Thirds)	7 17 6	7 7 6	8 3 6	7 12 0	8 13 2	7 17 6
Bran (Medium) ...	7 18 9	7 5 0	8 4 6	7 14 0	8 11 3	8 0 0
„ (Broad) ...	8 3 9	7 15 0	8 8 0	8 3 0	8 18 9	8 12 6
Feeding Treacle ...	7 11 3	7 12 6	8 5 0	7 18 0	8 8 9	8 10 0
Fish Meal... ...	18 10 0	17 10 0	...	18 0 0	...	...

* Oil and Albuminoids 40 to 42 per cent. † African. ‡ Roumanian.

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AGRICULTURE AND STATE INTERVENTION.[1]

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PART II.

POLITICAL judgments are never final, and the end of a legislative road is seldom seen from its beginning. The framers of the Act of 1883 may have realised that theirs was the first step towards the creation of a tenant's real right in the land, but even those best endowed with vision would have been horrified if asked to assent to the commonplaces of the Act of 1923, to say nothing of the possessory charter conferred on a few crofters in 1886, and on small holders throughout the country twenty-five years later.

Improvements.—Looking backwards from 1924 one is surprised that the expediency of encouraging sound husbandry in the final years of a lease, and the equity of compensating the tenant for generous treatment of the soil during these years, had not long before 1883 been generally recognised. Nevertheless, several well defined though not strictly chronological stages were traversed, before Parliament intervened to secure a concession to public interest and elementary justice in the form of compensation for unexhausted improvements. Voluntary contracts between enlightened landowners in Scotland as well as in England, aiming at the maintenance of a high standard of cultivation till the end of a tenancy, were known both in Scotland and in England by the middle of the nineteenth century. Contemporaneously Chambers of Agriculture and especially the Scottish Chamber urged the recognition of the residuary value of artificial manures, describing failure to compensate as a form of theft. Discussion resulted in a commission charged with the duty of enquiring into the probable effect on agricultural development of conceding tenants' claims. Then, positive legislation had a tentative beginning in the English Agricultural Holdings Act of 1875—ineffective because permissive only. But, by it, the way was opened for the Scottish Act of 1883, not a great measure in actual achievement, but in the establishment of new principles, a pregnant incident in the history

[1] The previous article on this subject appeared in Vol. VI., No. 4 of the *Journal.*

of our agriculture. Previous measures aimed at the redress of grievances, but this Act of 1883 asserted, more emphatically than ever before, the claim of the State to intervene in every contract of lease, and to compel both landlord and tenant to regulate the use of the land, not according to their own will, but the will of the State.

Private Ownership.—While there had been individual land reformers prior to 1883 having for their slogan "the land for the people," all statesmen ambitious of office accepted private ownership of land as unreservedly as the private ownership of coin. Neither the idea of imposing on landowners a trusteeship for the public interest, nor the possibility of creating a tenant right had emerged in Scotland before 1880. Both ideas were implicit in the Act of 1883, and there is scarcely anything in subsequent legislation not referable to the principles underlying it.

Modifications of Principle.—Besides the sanctity of private property, a narrower legal principle was challenged by the Act of 1883. The doctrine that whatever is attached to or mixed with the soil becomes *pars soli*, borrowed from Rome, had consequences favourable to the landlord. The doctrine had suffered exception in the case of attachments to land or buildings by a trader, but a farmer was not before 1883 regarded as a trader, and so had not the full benefit of the exception. The Statute of 1883 denied effect to this narrower doctrine, and carried the challenge further for the tenant farmer than for any other trader.

Consideration of certain details of the Act of 1883 shows the modifications of legal principle then effected by Parliament in the interest of a prosperous agriculture:—

(*a*) A landowner must compensate a tenant who has made improvements on a farm in accordance with a statutory code; the amount of the compensation is determined by the code—obvious derogations from property rights as then understood.

(*b*) Tenants may be removed for non-payment of rent, only at Whitsunday or Martinmas, and even then can claim the rights of outgoing tenants—in other words, can hold the land in spite of a breach of the letting conditions, and may receive something which on principle follows only on complete fulfilment of these conditions.

(*c*) To end a tenancy a landlord must give the notice prescribed by the Act,—a provision fatal to these removal clauses in leases so familiar to and so disliked by tenants.

(*d*) A tenant may bequeath his lease,—may ignore the destination in the lease and *deprive* the landlord of that selective right so precious to him.

(*e*) A fixture attached or a building erected by a tenant, for which the tenant is not entitled to compensation under the Act, may be removed by him within a reasonable time after the termination of the tenancy, provided the

landlord has had opportunity of taking it over at valuation—just without doubt, but a negation of the law of private property in land.

New Legal Presumptions.—Each of these new privileges was of course granted under conditions expressed in the Act—the need for consent in some cases, the obligation to give notice in others. For me the point of the legislation lies in the reversal of the relationship of landlord and tenant. The onus had hitherto been on the tenant to show himself entitled to compensation, to bequeath his lease, to remove fixtures. The State transferred the burden of proof to the shoulders of the landlord. The Act created legal presumptions for the tenant, which the landlord might rebut if he could.

Contracting Out.—The prohibition of "contracting out" is of special importance to this study. "Any contract or agreement made by a tenant by virtue of which he is deprived of his right to claim compensation under it in respect of any improvement specified in the schedule shall, so far as it deprives him of such right, be void." The fact that "substituted compensation" was permitted is not material. It meant that the State, while insisting on compensation, gave a certain elasticity to the new relationship between landlord and tenant, and certain concessions to the landlord which really emphasised the quality of what the State had done. For example, payment of compensation might be undertaken by the incoming tenant instead of the landlord, but this suspended, it did not cancel, compensation. The power conferred on the landlord to charge his estate with the compensation on obtaining judicial authority is also interesting. Both concessions speak eloquently of the birth of a tenant right capable of unlimited growth.

1900 Act: Penal Rents.—I have no doubt there was much talk of the spoliation of the landlord and of the "thin edge of the wedge." But I think that only a few understood the penetrating character of the wedge. Revolutions do not accord with the genius of Scotland, yet a system may withstand direct assault, which will shortly succumb to a process of legislative sap and mine. The legislators of 1883 took, perhaps unconsciously, the first step in such a process. The Act of 1900 has the technical disadvantage of being an amendment not of the Statute of 1883 but of the corresponding English Act, although it is made to affect Scotland by one of these declaratory clauses dear to Parliamentary draftsmen, but abhorred by laymen who detest legislation by reference. There is in the Act of 1900 no striking evidence of development in State intervention. The 1883 Compensation Schedule is repealed, and replaced by another slightly extended in scope, but adhering to the threefold division of improvements set up by the earlier statute. There is, however, one important exception. A common clause in nineteenth century leases was that which required the tenant to pay a penal rent if guilty of a breach of the lease. All are familiar with the clauses by

which a tenant was taken bound to pay an extra rent for each acre broken up beyond a prescribed quota. Such clauses could be so expressed that a Court could not competently modify them. Penal rent thus became an effective method of compelling a tenant to accept the landlord's theories of cropping and miscropping. It was an important step towards freedom of cropping when, in 1900, Parliament declared that, despite such penal clauses, a landlord might not recover more than the actual loss which he had sustained through a breach of tenancy conditions. Parliament had faced the possibility of conferring on the tenant a large measure of administrative freedom, but courage had been lacking, or the opposing interest had, for the moment, been too powerful.

1908 Act: Repetitions.—The Act of 1906 applied like that of 1900 both to England and Scotland. By its terms it did not become operative till 1st January 1909. Before that date the Agricultural Holdings (Scotland) Act 1908 had become law, and as a result the provisions of the Act of 1906 never became operative.

I am not here attempting an accurate summary of statute law. I am trying to trace the line of development in state control, consistent or inconsistent, consciously or unconsciously followed. Now the Act of 1908 reveals considerable progress on the line foreshadowed in 1883. In the matter of compensation for improvements, permanent or temporary, there are no material changes in principle. Some changes in detail may be noted in passing. The Acts of 1883 and of 1900 provided that a tenant could not claim compensation for an improvement "due to the inherent capabilities of the soil." This rule disappears from the Act of 1908, but the most distinguished commentator expresses the view that no practical difference results. While "the erection or enlargement of buildings" appears in Part I. of the Schedule to the Act of 1883, and the "erection alteration or enlargement of buildings" is found in the same place in the Act of 1900, and so cannot be undertaken without the landlord's consent, the following item is entered in Part III. of the First Schedule to the Act of 1908, "repairs to buildings, being buildings necessary for the proper cultivation or working of the holding, other than repairs which the tenant is himself under obligation to execute." Note, however, that the tenant must, before executing such repairs, give the landlord notice in writing of his intention, with particulars of the repairs, and is not to execute these unless the landlord fails to proceed within a reasonable time of receiving the notice. This qualification of the right is important, but the right itself is a significant addition to a farmer's administrative power, and an equally significant subtraction from property right.

A study of the Act of 1908 shows that in many respects it is only a re-enactment of the beneficial provisions of the Acts of 1883 and 1900, taking State intervention no further, *e.g.* (1) the compensation clauses with these minor alterations and additions; (2) the right of a tenant to bequeath his lease; (3) the tenant's

right of property in fixtures; (4) the restriction of the landlord's right to insist on the tenant's removal for non-payment of rent; (5) regulations as to notice to quit; (6) the rule as to penal rent. But even these must not be forgotton - their repetition emphasises the practical irrevocability of State decision. "The moving finger writes, and having writ, moves on."

1908 Act: New Provisions.—There are, however, provisions appearing in the abortive Act of 1906 and re-appearing in 1908, which are really new and notable encroachments on the private ownership and management of land. Instances are: --the right of a tenant to compensation for damage by winged game and deer—although the tenant is not permitted to kill these when found on his holding—freedom of cropping, the right to dispose of the produce of the holding, and, above all, the right to compensation for what is described as "unreasonable disturbance." The first may be no more than a sequel to the Ground Game Act, 1880; the second and third are in different categories. The third, though robbed of practical value by the language in which it was expressed, yet revealed a new legislative outlook of supreme significance.

As agriculturists know, some statutory rights may be surrendered by the tenant, others may not. Among the latter are the right to claim compensation for improvements, for game damage, for unreasonable disturbance, and the rule as to penal rent. In each of these instances Parliament has created a code which both landlord and tenant must obey. They are genuine cases of state intervention. In other instances, by conferring a right or privilege on the tenant, the Statute has merely shifted an onus from the tenant to the landlord. If there is no clause to the contrary in a lease, the relationship of the parties is regulated by the language of the Act which gives the privilege.

The Act of 1908, with nothing in it save freedom of cropping, the right of the tenant to dispose of produce, and compensation for "unreasonable disturbance," would still be memorable in the history of agriculture. The first two standing together are a Parliamentary declaration that all owners hold their land as *quasi* trustees. Says Parliament in effect:—a tenant must be allowed to cultivate in such a way as will take the best out of the soil. Private ownership, as understood in the nineteenth century, goes by the board. Moreover, the State has claimed the right to intervene through the tenant in the administration of all land.

Significance of Unreasonable Disturbance.—But that other provision, by which a tenant is to be compensated for "unreasonable disturbance," out of which parties cannot contract themselves, goes deeper still. Its operation under the Act of 1908 was, as already remarked, rendered difficult by vagueness of expression; but its embodiment in an Act of Parliament marks a resolution of the State to preserve the cultivator in the possession of land even contrary to the will of the landowner, a new conception of the relationship of all landlords and tenants, a new and

highly significant commitment of the State to intervention in agriculture generally. There had already been, with a view to fixity of tenure, more definite intervention in special cases in 1886 and 1911, as we shall see, but this new provision is universal and irrevocable. Although the landlord may rid himself of a tenant by paying damages, the result is now to establish a tripartite interest—that of the landlord, the tenant and the State—in all agricultural land. The obscure and unsatisfactory language in which section 10 of the 1908 Act declares the tenant entitled, *notwithstanding any agreement to the contrary*, to "compensation for the loss or expense directly attributable to his quitting the holding, which the tenant may unavoidably incur upon, or in connection with the sale or removal of his household goods, or his implements of husbandry, produce, or farm stock on or used in connection with the holding," is nothing to the point. The movement, begun in 1883, is in full progress. A new principle in relation to land is established. Less than twenty years ago, with specialised exceptions, a tenant could be dispossessed at the end of his lease without reason. Being in possession after 1908, he has a qualified guarded right to remain. For the Act of 1908 I claim no more. Nor is there any subtraction from the principle in the rule that if there is difference of opinion, and parties fail to agree, the settlement must be by arbitration, both with regard to "unreasonable disturbance," and other questions under the Act. The enforcement of arbitration is, in itself, an assertion of the State's claim to intervene. I think it is possible, after 1908, to express the State attitude to agricultural land thus: "You, the landlord, and you, the tenant, both hold the land as *quasi* trustees for the public interest. There is implicit in us, the State, the right even to acquire and administer the land itself. Whether it is expedient to do so remains an open question."

There was amending legislation in 1910, and a very unsatisfactory legislative attempt in 1920. But time need not be spent on either measure, because last year the legislature gave us a codifying statute applicable to Scotland only.

1923 Act: Its Universality.—Through a brief study of the Act of 1923, and of other statutes which will present themselves, I shall try to show the State in its latest attitude to agriculture. Observe at the outset that the Act of 1923 applies to all "holdings," that a "holding" is defined, as in previous measures, as "any piece of land held by a tenant, which is either wholly agricultural or wholly pastoral, or in part agricultural, and as to the residue pastoral, and which is not let to the tenant during his continuance in any office, appointment, or employment under the landlord." I make no special reference to market gardens. I emphasise, however, that the Act of 1923 applies to holdings within the scope of the legislation which culminated in the Small Landholders Act of 1911, as well as to other holdings.

Statutory Contracts.—Remember that Parliament does not by any legislation prevent A, a landlord, from entering into a

lease with B, a tenant. They may at will agree as to the subjects let, the date of entry, the rent, the date of the termination of the contract. But having permitted that, the State imposes on the parties another statutory contract. Some points in that contract the parties may, as we saw, ignore. Other elements in the statutory contract bind the parties, whether they will or not.

Five Points for Tenants.—The State, in making the contract for the parties, is intervening for the protection of one party, or the other, or in the public interest. In this Act of 1923, one sees the State operating in favour of the tenant from at least five different points of view. But the tenant should not regard the State as favouring the individual, but as endeavouring to adjust the balance between two trusteeships. In the main the intervention is not new, but whether a repetition of former enactments, or something novel, it is, always as before, a definite subtraction from owners' common law right, and an equally definite addition to the tenant's statutory right justified, no doubt, as a step taken in the public interest.

The five points of view reveal a tenant right comprising *Security of Tenure, Rent Restriction and Regulation, Freedom of Administration, Right to Transfer*, and *Compensation at the End.* Ownership of agricultural land has become a shadowy thing, no longer for its own sake desirable.

Fixity of Tenure: Notice to Quit.--Security of tenure is on a rising scale even within the four corners of the new Act, beginning from a mere codification of the rules regulating the times when, and the manner in which notices to quit may be given, passing through protective provisions for an impecunious tenant who cannot pay his rent, up to the possessory charter in the sections relating to compensation for "unreasonable disturbance." This seems to me a true view of the development of the legislative mind in spite of the order of the sections. Both landlord and tenant have long known that the obligation to remove at the end of a lease "without warning away or process of removal" is surplusage; but the Act of 1923 is even more stringent, more zealous in its care for the tenant than its stringent predecessors. It prescribes a minimum of one year's notice and a maximum of two, where the lease is for three or more years, and entered into before 24th December 1920, or for two years if entered into later; a minimum of six months' notice in every case where a lease for less than two years was entered into prior to 24th December 1920, or for any period less than two years after that date. If notice is not timeously given at the close of a lease, there is always a renewal for a year by tacit relocation. But when there has been renewal in this way, the notice may never be less than one year, nor more than two, if given after 31st May 1921. Is the intervention not over anxious in this matter of notice? It is little consolation for the landlord that the rules as to notice do not apply when a lease contains provision for resumption for planting, building, feuing, and never to tenancies for less

than a year. What, by the way, is a "building" purpose? Could an owner resume a piece of market garden to build a private garage? Doubtless, an owner may remove a judicially bankrupt tenant, or one who by failure to pay rent has incurred an irritancy under his lease. In practically every case an owner may now raise an action of removing, without notice to quit, after the tenant is six months in arrear. Even so the removal must, as after 1883, be at Whitsunday or Martinmas, and the defaulting tenant has an outgoing tenant's rights. Moreover, the severer rules of the Act of Sederunt of 1756 can not now be invoked, where the application of the rules of the new Act relating to notice is competent. Parliament has certainly seen to it that an agricultural tenant, and the interests of agriculture, will not suffer through the abrupt termination of tenancies.

Though not strictly relevant here, I direct attention to section 27 of the new Act, as a further expression of the legislative care for the security of the tenant. If a contract for the sale of land held from year to year is made, a current or unexpired notice to quit is to be null and void, whether given before or after the commencement of the Act of 1923, if the contract is made and notice given by the same person. The section does not apply, if the tenant has after 19th August 1919 and before the date of the contract of sale agreed that the notice to quit is to be valid. Surely a clause redolent of a Commons committee room, where the original clause has been amended, altered, added to, and again altered and amended till the original idea has been lost in a maze of words.

Crofters Act.—And here, when one is seeking to outline the story of fixity of tenure, one must turn aside to consider the first legislative movement towards it, not a camouflaged security, but a security in terms—a piece of patchwork law-making not referable to any general principle, but defended as a measure of justice to a downtrodden class in the community. The Crofters Act of 1886 was a measure of protection to brave men who had suffered grievously through a determination bred in the bone to cling to their native soil. It was at once a distant echo of the angry outburst created by the clearances of the early years of the nineteenth century, and a protest, well or ill founded, against the alleged displacement of the cottar and crofter for the pleasure of the millionaire. The protagonists of the movement perhaps failed to recognise the essential benevolence of the relationship between Highland landlord and tenant. Be all that as it may, the importance of this Act lies in the stride which it unconsciously takes towards the ultimate expropriation of the landowner. A "crofter," by the Act of 1886, is any person who at the passing of the Act is tenant of a holding from year to year, who resides on a holding rented at not more than £30 in money, and situated in a crofting parish. The definition of the term "crofter" includes his heirs or legatees. The Act applied only to such portions of the seven Counties of Argyll, Inverness, Ross, Cromarty, Sutherland, Caithness and

Orkney and Shetland, as are declared by a Commission to be "crofting parishes or aggregates of crofting parishes." How limited in space, but how immensely significant it is all seen to be now! For the first time in the history of agriculture the State conferred on an agriculturist—the crofter—and his successors, a tenure *in perpetuity*, at a rent fixed not by private bargain, but by a public tribunal created by the Act. The rent is arbitrarily fixed at that of the year 1887, until altered by agreement, or by the Crofters' Commission, at the instance either of the landlord or the crofter. Doubtless, the crofter had to obey certain "musts"—pay rent; make no attempt to assign; refrain from dilapidating buildings or deteriorating the soil; must not subdivide; must not violate any written agreement; must not violate any proprietary rights (his very emergence was to the landlord of the day an astounding violation of proprietary right); must not open a public house. The significance of all these conditions is that they are statutory not contractual, made for, not by the contracting parties, made by the State itself.

No Free Sale.—Do not let us overstate the significance of the Crofters Act. There is no doubt fixity of tenure and fair rent, but as yet there is nothing like "free sale" of the tenant right. Yet there is considerable latitude in the choice of a successor, although strangely enough the right to bequeath, under the Crofters Act, was less absolute than that conferred on an ordinary agricultural tenant by the Act of 1883. The right to succeed under the Act of 1886, failing a bequest by the crofter, was in the heir-at-law, or eldest heir portioner. On the other hand, a bequest might be made to a member of the crofter's family, to his wife, or to any other person, who, failing nearer heirs, would succeed in intestacy. The heir or legatee was bound to claim possession within a reasonable time. The landlord had right to object to the successor, or to represent that the land should be used for the enlargement of another or other holdings, where it descended to remoter successors than a brother or grandson. All is done in an atmosphere of equity, but the State had gripped for the tenant certain sections of Scottish soil with a firm hand—a hand waxing bolder as the years passed. Nor did Parliament forget to confer on the crofter a right to compensation for suitable improvements, executed or paid for by himself or his predecessors without obligation. The improvements included most of those contemplated by the Schedule, Parts I. and II. of the Act of 1883, although certain rules relating to consent and notice were not made to apply.

Crofters Act Significance.—And so despite its strict localisation, the condition which it attached to permanency of possession, the limited right of bequest, the exclusion from its scope of holdings let to the landlord's employees during the continuance of employment, of holdings let to schoolmasters during tenure of office, to hotel keepers or tradesmen settled for the benefit of the district, the Act, seen in the light of subsequent events, contained

no less than a triumphant declaration of the right and duty of Parliament to shape not only certain minor incidents of an agricultural holding, but all the most essential elements in agricultural contracts. A legislative point had been reached, without Parliament or people knowing it, from which retrogression was never possible. The amending statutes which followed, containing provision for enlargement of holdings contrary to the will of the owners, for the disposal of holdings to which succession had failed, for resumption by the landlord for specified purposes, do not mark important advances in public control. But even where they are *ex facie* concessions to the landlord, they do not detract from, but rather serve to emphasise the general principle of State control in the public interest, of which the first Crofters Act is so remarkable an expression.

Administrative Concessions.—It seems to me surprising that twenty-five years passed before Parliament gave the principles underlying the Act of 1886 a wider application. Agricultural interests had not been neglected in the interval. Apart from the progressive movements embodied in the Act of 1908, there was the palliative legislation of the Agricultural Rates Act of 1896, plus administrative concessions to the farmer in the matter of Income Tax. Whether the relief thus given ultimately benefited the landowners only, as some politicians contend, is not material. The interest again lies in the recognition by the State of its right and its obligation to foster agriculture even in disregard of strict economic theory.

Small Landholders Act.—This wider application is found in the Small Landholders Act of 1911. That statute boldly asserted the duty of the State to protect tenants of a particular class throughout the whole country in the possession of their holdings. Localisation of protection was abandoned, and the Crofters Commission became the Land Court. A study of the 1911 Act leads one to think of the State, between the years 1886 and 1911, as silently extending its protectiveness, until ready in the latter year to entrench not only the existing crofter, but the existing yearly tenant, and the qualified lease holder, *i.e.*, every tenant of a small holding anywhere in Scotland who could satisfy a statutory tribunal—the Land Court—that he, or his predecessors in the same family, had provided or paid for the whole or the greater part of the buildings or other permanent improvements on the holding, without recovering from the landlord or any predecessor in title, payment or any fair consideration therefor. The landholder, who is the existing crofter, the existing yearly tenant, or qualified leaseholder under a statutory name, is subject to conditions similar to those found in the Act of 1886. He must reside on or within two miles of his holding, and must cultivate it by himself or his family, with or without hired labour. He has fixity of tenure at a fair rent subject to review by the Land Court at fixed intervals. He can leave his holding at the end of any year, but he cannot assign his right during his lifetime, *except on the ground of infirmity, and*

then only to a relative, although he can bequeath his lease under certain statutory conditions. While thus observing the gradual development of Scottish tenant right, it should be remembered that it never became equal to the corresponding Irish right. It is not a marketable subject, and cannot directly, at any rate, be turned into a fund of credit. Now every one recognises an equity in State intervention to protect in possession a tenant who has erected buildings or made other permanent improvements on his holding at his own expense. But the State in 1911 in giving birth to the "Statutory Small Tenant" abandoned all pretence at adherence to any such simple principle. Every tenant of a holding, the rent of which does not exceed £50 in money, or which does not exceed fifty acres in extent, who resides on, or not more than two miles from his holding, and cultivates it by himself, or members of his family, with or without hired assistance, was at the passing of the Act of 1911, and still is potentially, a "Statutory Small Tenant," for he may apply to the Land Court at the end of a current lease for a declaration that he is one. Here is a line drawn arbitrarily between tenants of one size of holding and tenants of another, without reference to any defined or definable equitable or legal principle. Such a dividing line cannot in the nature of things be permanent.

1911 Act Significance.—This new attitude of the State towards tenants compels attention. In simpler days a tenant failing to produce a contract entitling him to remain was bound to remove when required. The position of the landholder and the statutory small tenant in relation to the landowner is reversed. They may cling to their holdings unless their landlord can submit a statutory ground for their ejection. Onus, which counts for much in every department of law, is finally shifted. The tenant's right to remain is assumed, the landlord must show cause for ejection. Moreover, the Land Court practically eliminates private contract between all landlords and tenants subject to its jurisdiction. No doubt the Statute, in terms, encourages both to enter into private bargains; but behind such statutory encouragement, both landlord and tenant see the tribunal—a State embodiment—ready to fix a "fair rent" for the landholder and an "equitable rent" for the statutory small tenant, and to renew for a stated period the tenancy of the latter. The landlord may even find himself bound to accept as tenant one personally obnoxious to him. I remember a case in which a landlord claimed to refuse renewal to a tenant who had written to him extremely offensive letters which would certainly, in former days, have amply justified the landlord in terminating the lease at the earliest possible moment. A *pro forma* expression of regret was held to expiate the offence, and the tenancy was renewed for seven years.

Administrative Power.—A minor yet significant point may be noticed. The Board of Agriculture has power to acquire land compulsorily for the constitution of new holdings. In this connection the wind has not shifted to the same extent. The

expediency of establishing such new holdings has still to be established as against the landowner. But the fact remains that the creation of such holdings no longer depends on the landlord's consent.

1908 and 1923 Acts: Compensation for Disturbance.—Keeping in mind the provisions of the Acts of 1886, 1911 and 1908 with regard to security of tenure, note that the Act of 1923, using the same terminology as in 1908, has given security far greater both in kind and in degree. Reverting for purposes of contrast to the 1908 Act, one finds it saying in effect this:—If a tenant has been compelled by his landlord to quit his holding without sufficient cause, and for reasons inconsistent with good husbandry, or if a renewal of tenancy has been refused although requested in writing a year before the termination of the tenancy, or if an increase of rent has been demanded on account of an increase in the value of the holding occasioned by improvements executed by the tenant without his receiving some equivalent from the landlord, and such increase results in the tenant quitting the holding, then the tenant, in addition to compensation for improvements, *despite agreement with the landlord to the contrary*, is entitled to compensation for all loss and expense attributable to the quitting of the holding. That is, sympathetically construed, compensation for "unreasonable disturbance" in an exact sense. The possibility of being compelled to compensate a quitting tenant for loss thus resulting lessened the result of arbitrary ejections, notwithstanding qualifications and exceptions, and the use of language so vague and circuitous as almost to invite litigation. Parliament, it seems to me, had the same objective in Section 10 of the Act of 1908 and the tenure provisions of the Small Landholders Act, although under the latter, a tenant may remain till legally removed, while under the former, he was bound to quit, subject to a claim to compensation.

I omit the Act of 1920, because it was not exclusively a Scottish Statute, and was in any event superseded by that of 1923. The conception of compensation for "unreasonable disturbance" in the Statute of 1923 is wholly different from that of 1908. In 1908 the legislator thought of subjecting an unreasonable landlord to the payment of ill-defined compensation under ill-defined conditions. The legislation of 1908 was a threatening gesture directed against a bad landlord. But the Act of 1923 affects every landlord. Compensation is due under it in every case where a tenant leaves in consequence of a notice to quit, or something equivalent to a notice to quit, unless the tenant has been guilty of one or more acts or omissions which can be described as statutory offences. If, for example, he has not cultivated in accordance with the rules of good husbandry, has failed to pay rent due when called on, or failed to remedy some remediable breach of his tenancy, has committed an act of bankruptcy, has failed to enter into an arbitration with regard to rent to be paid after the termination of the current tenancy, then

the landlord may remove him without compensation, not otherwise. The lapse of the tenant right to claim compensation, should the notice to quit be timeously withdrawn, and other modifications of the tenant's right do not touch the general principle. The breadth of the principle is indeed strikingly emphasised by a provision under which a tenant may call on the landlord to arbitrate as to the rent to be paid at the end of a tenancy, and to receive compensation as for unreasonable disturbance if he quits the holding because of the landlord's refusal. The enforcement of arbitration in every difference of opinion emerging under the section, the fixing of the mininum and maximum compensation at one or two years rent of the holding, both serve to emphasise the determination of Parliament to forget the quondam sanctity of private ownership, and the elimination of that freedom of bargaining under equitable conditions, which, less than two generations ago, was the chief objective of State intervention. I am interested especially in arbitration for the determination of rent, for I see in this the possibility of further development. Amid this negation of property right one occasionally sees an almost pathetic desire in the framers of the Act to preserve to the landlord some shadow of his former control. But the right of the landlord to make a valuation of the stock, etc., as a condition precedent to the tenant's claim for compensation, the tenant's obligation to give notice of intention to claim, and other minor qualifications of tenant right, merely point the more clearly to the complete legislative change of front. Before 1883, Parliament had resolved that agricultural tenants would not any longer be victims of oppression. To-day the position is that farmers, the National Government, and the great body of the people have, through the declarations of Parliament, indefeasible rights in the soil as a medium of production, the duty of the legislator now being to deal as gently as may be with those who happen to be its owners.

To describe Section 12 of the Act of 1923 as the provision of compensation to tenants for "unreasonable disturbance' is I think a misnomer. *It is rather a statement of the only conditions under which an owner may resume possession of his land without being subjected to a heavy monetary penalty.* That being so, private ownership of land in the old sense is not dying but dead.

Minor Tenant Privileges.—I merely glance at some of the minor privileges secured for tenants by the Act of 1923. Even these, whether new or repetitions only, help to make clear the point reached by the Act. Security of tenure may be viewed as the tenants' main position—minor rights as defensive outposts. Freedom of administration has its three subdivisions—penal rent, unfettered cropping, and right to dispose of produce. The rule as to penal rent dates from 1900. That rule is preserved in 1923. The provisions conferring freedom to crop and to dispose of produce first seen in the abortive Act of 1906, later in the Act of 1908, are now repeated without modification of principle. But all derive new significance from their association with that practical

security of tenure implied in compensation for disturbance. At their beginnings they indicated a tendency. Now they add strength to the current which is, by and by, to sweep away the last traces of the old order. What more reasonable, under the old régime, than for a landlord to say:—"I have the paramount interest in the soil. Only a certain proportion of the arable land is to be broken up each year, and all must be cropped thus and not otherwise, and if you (the tenant) break up more, or crop differently, you will pay me £5 per acre, instead of £1, 10s." The old argument has finally broken down, and the cause to which the collapse may be attributed scarcely matters, whether it be the open or veiled insistence on the alleged community right in land, or the clamant need for the development of a bold initiative in the trained agriculturist.

Right of Transfer.—Bold in other directions, the State, in dealing with the right of transfer has been hesitating and timid. At common law, as is well known, a lease is heritage and descends failing a special destination to the heir-at-law of the lessee. The Act of 1883, for the first time, as already seen, gave a tenant the privilege of bequeathing his lease, subject to the Sheriff's right to nullify the bequest, if of opinion that the landlord's objections to the legatee were well founded. By the Act of 1923 the position is as it was forty years ago. It must have seemed to the landlord of that day a hateful piece of legislative tyranny to give A the right to choose a tenant for a farm belonging to B. But, to those who have studied other agricultural changes and movements, it is altogether surprising that there has been no real progress towards a right to transfer. Even in the case of holdings within the limits of the 1911 Act, the right of bequest or transfer is no wider than in others. I remind my readers that the only point at which a right to transfer a holding, during lifetime, emerges is when a landholder or statutory small tenant is permitted, in case of infirmity, to pass on his holding to a member of his family. There is even a contrary current apparent in one clause of Section 12 of the Act of 1923. Compensation for disturbance is not payable where the tenant holding a lease has died within three months before the date of the notice to quit. This notice must be otherwise permissible, but the intention apparently is not to deprive the landlord of his right to resume possession, if he can competently give notice to quit within three months of the death of the tenant. This Parliamentary timidity is not explained by a tenderness for the landlord, but is probably referable to public policy in a different region. A legalisation of transfer might turn the tenant's right into a possible pledge for advances, contrary to the true interest of the tenant, and it might precipitate a scheme of land purchase for which the people of Scotland are not believed to be ready.

Tenants' Real Right in Land.—Be that as it may, every tenant has now a real right in the land convertible into money and capable of transfer to the tenant's representatives. Compensation for unexhausted improvements under the Act of 1883 was

the beginning of this right, though few saw it to be so. The right to bequeath implied it. The possibility of transferring the burden of payment from the landlord to a new tenant isolated the right, and gave it an independent existence; the privilege of removing fixtures conferred by the act of 1883, and continued by subsequent legislation, materially increased the right; fixity of tenure, whether under the 1911 Act or under the Act of 1923, consolidated it and rendered it unassailable. Unless legislation takes a sharp turn in some other direction, I do not see how the recognition of the tenants' claim to freedom of transfer can be much longer delayed.

High Farming.—But there was something in the Act of 1920 repeated and developed in the Act of 1923 which, in relation to the tenants' real right in the soil, deserves a separate paragraph. Long before 1920 claims by outgoing tenants for compensation for "cumulative fertility" were known. Their validity was negatived by the Court of Session, at least when stated in these terms. Now, by section 9 of the 1923 Act, following up section 16 of the 1920 Act a tenant, on quitting a holding, may, if he satisfies an arbiter that the value of a holding to an incoming tenant has been increased during the tenancy by the tenant's adoption of a standard of farming, or system of farming which has been more beneficial to the holding than the standard or system, if any, required by the lease, may be awarded compensation equivalent to the increase in the value of the holding. The qualifications of this new right, the need to make a record of the holding, the obligations as to notice, and other safeguarding provisions, whether in the interest of the owner or the tenant, do not affect the principle. In brief, the provision invites the tenant to treat the land as if it were for the time being his own, with the statutory assurance that he is creating for himself an inalienable right which, in due time, may be submitted to the acid test of convertibility into money.

War and Post-War Incidents.—I do not dwell on any of those recent measures directed towards the maintenance of prices. I regard these as incidents of war and post-war conditions, and as clearly contrary to the tendency of legislation since 1883 to put the tenant in a position of independence and self-responsibility, although I cannot exclude the possibility of a return to subsidising legislation in the future.

Rent Arbitrations.—The Act of 1923 has added yet another to the privileges of the tenant, rounding off and completing that real right in the tenant of which I have spoken. At the commencement of every tenancy rent is still regulated by the law of supply and demand and the proprietor's views; but sooner or later, as the result of section 12 of the Act of 1923, every rent may become the subject of arbitration. Thus Parliament has taken a step which will in the end deprive every landowner even of the right to say what the rent of his land is to be, just as effectually as that right was taken away in special cases, first by

the Act of 1886, and afterwards by the Act of 1911. Public necessity is, it may be, a sufficient reason for any legislation, but who can wonder if a landowner is sometimes heard to say: "The toad beneath the harrow knows exactly where each tooth point goes."

Further Changes certain.—If such is a fair statement, this may be said with certainty:—neither land tenure nor land administration can remain as they are. Progress may be in one or other of two directions. No one contemplates to-day the purchase of agricultural land merely for the sake of holding it and of letting it. Sport, amenity of residence, that mysterious land hunger which grips, may account for occasional acquisitions, but the day of land owning in the old sense is over. The State has willed it so.

Suggestions.—Some find the solution of all agricultural problems in the delivery of the land into the hand of the cultivating owner and the peasant proprietor. The logic of recent State intervention is that the soil should be owned by the man who cultivates it, but that does not necessarily mean ownership by individuals. A preliminary would probably be the creation of a statutory tribunal for the determination of rents, which would become the basis of a scheme of land purchase more or less on Irish lines. Such a tribunal would not be a startling advance on rent arbitrations as contemplated in the 1923 Act, and such a scheme of purchase would fit in with the breaking up of large estates so common in recent times.

The idea is attractive to many who, like myself, see in it the best promise of reinvigoration for the race by close contact with the soil; who hope also for the preservation of that self-reliance in the individual, and stability in national institutions, associated with occupying ownership. But the resulting problems are difficult. I suggest only one line of inquiry. Can a sufficient number of agriculturists with the necessary skill, energy and capital—especially capital—be found for their solution on these lines? Even cultivating ownership, desirable as it is in itself, may not solve the economic problems involved. I dare not touch on controversial political questions, but there is one great party in the State who for reasons sincerely held are opposed to development on these lines, not chiefly because of the practical difficulties, but because they regard private ownership as retrograde, not progressive, and as inimical to the final substitution of State for individual control. Whichever policy may be best for Scotland, it is certain that there will be further State intervention. Throughout a period of not less than 500 years the Government of this country has been driven to concern itself more and more in the welfare of agriculture, and it may be that nationalisation, or socialisation of land, which certain impatient reformers once vehemently demanded and expected to accomplish at one blow, will arrive by a gentle process of evolution.

An Appeal.—A purchase scheme under the auspices of the

State may be necessary, whether development proceeds on the one line or the other. If so, while I hold no brief for landowners, I feel that they have known something of the upper and nether millstone, and I venture to plead for fair, even generous treatment for them at the hands of the nation. I can well imagine one of their representatives saying in bitterness of spirit to a Minister of State; "In the public interest you have dilapidated our property, and now, in the public interest, you propose to buy it."

THE MANURING OF GRASS LAND FOR HAY AT ROTHAMSTED.

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THE historical experiments at Rothamsted Experimental Station include, amongst others, those on the mixed herbage of old grassland on which there is no record of seed having been sown. Started in 1856 these experiments have gone on continuously, and have been examined periodically by analyses of the hay crop. William Fream, describing these in 1888, says that for many years previous to 1851 the meadow was dressed occasionally with farmyard manure, sometimes with guano or other purchased manure, and it yielded a crop of hay of from 1¼ to 2 tons per acre. After some preliminary experiments the complete scheme was organised in 1856. The first crop of each year was cut as hay and the aftermath grazed by sheep till 1872, but as the grazing obscured some of the effects of the manures, it was discontinued and the aftermath was secured either as hay or as green forage.

The most recent report[1] has been compiled by Dr Winifred Brenchley, the botanist who now carries on the work of a long line of eminent agricultural botanists associated with Rothamsted. The book is quite moderate in size, but a glance at its contents will show that its preparation has involved a great amount of labour. Great care has been taken to suppress unnecessary detail, and to bring the outstanding results into bold relief, yet in spite of simplification of results and lucidity in presentation, the book cannot be described as easy reading.

The basis of the work is the periodic hay analysis of the herbage, originally described by Lawes and Gilbert in 1880 and 1882 in reports printed by the Royal Society and amplified in 1900. Every five years representative samples of the mown hay are taken and separated by trained assistants. Some years the separation was a simple one, into grasses, leguminosæ and miscellaneous, but from time to time, as in 1914 and 1919, complete separations were made, each blade of grass, clover or

[1] "Manuring of Grass Land for Hay," by W. E. Brenchley, D.Sc., *Rothamsted Monographs on Agricultural Science*, 144 pages, Tables and Diagrams. (Longmans, Green & Co., London, 1924.)

other plant being put into its own pile. As the samples were from 12 to 20 lbs. each, they were representative of the crop, and as the work occupied months it is hardly necessary to point out that the Rothamsted hay analysis is a remarkable example of thoroughness.

The results obtained apply in the first place to the herbage of old permanent hay meadows, of which there are large areas in the Midlands of England. At Rothamsted the meadows are cropped only for hay, but in ordinary farm practice, grassland is usually grazed for some part of the year. In spite of this limitation, it seems to us that the Rothamsted results may be applied to other types of grassland, and it is proposed here to discuss them with reference to all grassland, even where the complication of grazing comes in. In the north the commoner practice, on both lowland and upland farms, has been to break up the old grassland periodically, to crop it for several years, then to lay it down to grass by sowing a mixture of grass and clover seeds; hence even old grass parks are young in comparison to these century-old English meadows. The Rothamsted experiments have a more direct bearing on old grassland like policy parks, the hay meadows of sheep farms, and other old grassland rarely or never broken up since originally reclaimed. The argument may be carried even further, that these Rothamsted results have a bearing on purely grazing grassland of the hill pasture type.

The plots at Rothamsted are now twenty-three in number, and each one has been manured continuously since 1856 by a simple or a mixed manure, except in some cases where the herbage disappeared or was in a useless state. For example, the lack of lime became so conspicuous that it had to be applied, at least on part of a plot. The original experiments included farmyard manure, guano, nitrate of soda and sulphate of ammonia as sources of nitrogen. The only phosphatic manure used was superphosphates, so that these experiments give no information on the effect of the modern phosphatic manures, such as basic slag and mineral phosphates. The "complete" mineral manure of the period when the experiments began was 3½ cwt. superphosphate (37 p.c.), 500 lbs. sulphate of potash, 100 lbs. sulphate of soda, 100 lbs. sulphate of magnesia. The experiments include trials of complete mineral manure with and without the various nitrogenous manures, and also incomplete mineral manuring, where items such as superphosphate, potash, etc., have been omitted. Details cannot be included here, and for them reference must be made to Dr Brenchley's book, or to other accounts such as Sir A. D. Hall's *The Book of the Rothamsted Experiments* (Murray, 1905). Nor need be discussed here the merits of the mixtures of manures used. The point is that certain manures were used for a long time and have produced effects on the herbage, and it is the lessons from these that are being brought forward.

If the average yields of hay for recent years are arranged in order, they form a series of groups. A consideration of these brings out some useful facts on the relation of manurial substances

to the herbage of grassland. The groups are founded on Dr Brenchley's book, with slight modifications. Many details must be omitted.

I. **"Poverty Grass" Plots.**—The lowest yields, 8½ to 13 cwts. of hay per acre per annum are, as might be expected, on the unmanured plots bearing the Rothamsted numbers 3 and 12 (always unmanured), 2 (no manure since 1863, after farmyard manure 1856 to 1863), and 5(*1*) (no manure, after ammonium salts 1856 to 1897). There has been a steady decrease in hay during the years, and now the herbage is short, late in starting in spring, and giving a light leafy hay. Grasses predominate up to two-thirds of the herbage, including mainly bent (*Agrostis*), sheep's fescue (*Festuca ovina* and varieties), Yorkshire fog or pluff grass (*Holcus lanatus*), sweet vernal (*Anthoxanthum*), and only one common hay-grass, cocksfoot (*Dactylis*). Leguminosæ are sparsely represented, rarely amounting to 10 per cent. and consisting usually of birds-foot trefoil (*Lotus corniculatus*). A feature of these plots is the large amount of miscellaneous "weeds," sometimes 50 per cent., including yellow hawkbit (*Leontodon hispidus*), plantain (*Plantago lanceolata*), and hard-heads or horses' knots (*Centaurea nigra*). Anyone familiar with the herbage of sheep farm hay meadows will recognise the similarity; hence one must conclude that in too many cases these are yielding only poverty hay, and a shepherd may tell you he prefers it. The same grasses, the same scarcity of clover, and a great abundance of weeds distinguish even the enclosed fields[1] of hill farms, and many policy parks. In the Rothamsted plots ryegrass, meadow fescue, tall oatgrass, rough and smooth-stalked meadow grasses, such as are sown in grass seed mixtures, were originally present, but they have disappeared or have become reduced almost to vanishing point, and only cocksfoot is left. The same depreciation can be seen where grazing takes place on unmanured land. In our own experience a series of grass mixtures sown at Dreghorn in 1914 are now mainly bent and poverty grasses, with some cocksfoot and crested dogstail, but wild white clover is still strongly in evidence. Lime applied to this poverty grass at Rothamsted in the earlier years of the experiments was beneficial, but in recent years fresh dressings have failed to give much response.

II. **Ammonium Plots with Deficient Mineral Manuring.**—Next to the poverty plots come a somewhat expected pair with from 13 to 15 cwts. of hay, namely, plot 1, sulphate of ammonia, 220 lbs. each year since 1863; and plot 4 (*2*) ammonia, 440 lbs., with 3½ cwts. of superphosphate. On the former, ammonia alone, the herbage early in the year resembles the unmanured, being patchy and late in starting; but after the sulphate is applied the grass becomes fairly long and dark green, though the hay yield is still low. Grasses form the bulk of the herbage, and the principal species are still the poverty ones. Leguminosæ have

[1] *See* analyses in "Basic Slag and Mineral Phosphates on Hill Pastures," *Scottish Journal of Agriculture*, vol. vi., July 1923.

entirely disappeared and miscellaneous weeds are abundant. The addition of superphosphate brings earlier growth in spring, but the principal grasses—sheep's fescue and sweet vernal—are poor hay-producers, and they form a close mat which decays into a dry, peaty covering over large patches of the plot. Leguminosæ are absent and weeds are still abundant. The encouragement of sweet vernal grass, so characteristic of this plot, gives a false impression, for it becomes green early in the year and yields a very light hay. Applications of lime to these plots brought some improvement. On superphosphate with ammonia, lime greatly improved the herbage, producing a more even growth, fresher in spring and including taller grasses for hay. The poverty herbage of these ammonium plots cannot arise from the lack of nitrogen, and that acidity of the soil is partly responsible is shown by the beneficial effect of lime. A mixture of superphosphate and ammonium sulphate is a common top-dressing for hay meadows; but, as both manures produce acidity, it would appear that basic slag or mineral phosphates, both containing some lime, should be substituted for superphosphate, and nitrate of soda for ammonia. This is supported by a recent experience when a dressing of ½ cwt. sulphate of ammonia and 3 cwts. of supers. was applied to about twenty hay meadows; where these manures had not been used previously there was an improvement, but if these manures had already been used the result was usually disappointing.

III. **Low-yield Mineral Plots without Nitrogen.**—The next three plots in order of yield, with an average of 17 to 19 cwts. for the last five years are:—Minerals without potash (plot 8), superphosphate alone (plot 4 ($_1$)), and superphosphate with sulphate of potash (plot 5($_2$)). In all three the herbage is still of the sheep's fescue, pluff grass, bent type, late in starting in spring and inclined to form bottom herbage rather than hay. The presence of taller grasses like cocksfoot, foxtail and tall oatgrass has increased the hay a little over the true poverty plots. The effect of omitting potash (plot 8) is to produce a rather pale bottom herbage; a satisfactory feature is the presence of leguminosæ, including wild red clover, but the abundance of hard heads (*Centaurea nigra*) and plantain (*Plantago lanceolata*) still suggests poverty. Superphosphate alone has increased the taller grasses and drastically reduced bent (*Agrostis*), and the leguminosæ, suppressed where ammonia was used, have increased with superphosphate alone. Weeds are still abundant, *e.g.*, sorrel, hardheads, yarrow (*Achillea millefolium*) aud field rush (*Luzula campestris*).

Prominence has been given to these groups of poverty plots because their herbage recalls much of the grassland of this country. Bent and sheep's fescue make up much of the herbage of our hill pastures, where they may be regarded as the natural herbage of the greener hill land. But in so-called improved land this type is also very common, and there it represents the results of starvation. Where bent and sheep's fescue prevail, there is

late growth in spring, and the gradual formation of a close, turfy mat so deadly to all the better grasses. Pluff grass (*Holcus*) and sweet vernal bring an early greenness in spring which is deceptive, because neither of these grasses is relished by stock, and is left ungrazed where better are available. Hay from these four grasses is light in weight, and it is common as the meadow hay of sheep farmers. The persistence of cocksfoot on these plots shows that it can stand on poorish land, and, being early, it adds considerably to the grazing if prevented from becoming coarse. The scarcity of leguminosæ on most of these plots is not good for the herbage, though it is interesting to see the persistence of birdsfoot trefoil or crows-toes (*Lotus corniculatus*), the commonest yellow-flowered trefoil of hill pastures. Abundance of plants which are neither grasses nor clovers would seem to be an indication of poverty. It is evident on these plots that with starvation the herbage yield falls steadily, and once down it is not easily increased by top-dressing. On plot 5 (2), which received ammonium salts, 1856-1897, an improvement might have been expected by a change to minerals without nitrogen, but so far as hay yield goes this has not been the case at Rothamsted. Another lesson is the danger of one-sided manuring, and everything is in favour of the importance of changing the manures from time to time.

The remaining 14 plots have either maintained the original yield of about 25 cwts. or have increased. Some features of these may be briefly indicated.

IV. **Mineral Manure Plots without Nitrogen.**—Three plots yielding from 25 to 30 cwts. of hay have received the complete mineral manure; plot 7 all the time, plot 6 since 1868 after ammonium salts, and plot 15 since 1875 after nitrate of soda. The steady yield of these plots shows that mineral manures are capable of keeping up fertility, but not of increasing it permanently. The herbage in each plot forms a close bottom, but is fairly late in starting in spring. Sheep's fescue, bent and pluff grass are still abundant, but the hay yield is increased by cocksfoot and foxtail. Leguminosæ vary with season and sometimes reach 40 per cent.; yellow vetchling (*Lathyrus pratensis*) is the commoner one, with traces of red and white clover. The weeds are reduced, but plantain and sorrel are still abundant, and yarrow (*Achillea millefolium*) is a prominent plant on these mineral plots. Application of lime has no marked effect, though acting slightly in the right direction by increasing foxtail and leguminosæ and reducing sweet vernal grass and weeds. The effect of potash salts (plot 7) is noteworthy when they are added to the same mineral mixture as on one of the poorer plots. The yield is considerably increased by the taller grasses, and the light colour indicative of lack of potash is improved, though not so much as when nitrogen also is included.

V. **Plots with Ammonium and Minerals.**—The injurious effects of ammonium salts with insufficient minerals have already been illustrated (group II.). On three plots (9, 11(1) and 11(2))

the yield has been nearly trebled by combining ammonia (440 lbs. and 660 lbs.) with complete minerals. The yield has only been doubled where superphosphate has been omitted (plot 18), or potash (plot 10). During the first ten years of manuring, these plots gave 2½ to 3½ tons per acre, but now the best of them ($11_{(2)}$) gave just over 2 tons per annum during the last five years. All the five ammonium plots are described as patchy, especially in the early part of the year. A dry, peaty coating tends to form, and although seedlings, such as pluff grass, may appear, they do not survive. The spring growth is early, and the application of the ammonium salts encourages a dark-green herbage of rank, coarse grass that lodges badly in some seasons. This destroys the bottom grasses and accounts for the uneven patches. Grasses are completely in possession, leguminosæ are entirely absent, while weeds are considerably reduced with the smaller amount of ammonia (440 lbs.), and almost suppressed with the heavier dressing of 660 lbs. The four grasses, bent (*Agrostis*), sheep's fescue, pluff grass and sweet vernal are still abundant; but the taller grasses are encouraged, *e.g.*, foxtail, tall oat and cocksfoot. These grasses vary in yield according to the season, but with the larger amount of ammonia there has been a marked reduction in bent and cocksfoot. Sorrel (*Rumex acetosa*) along with sheep's fescue are common with 440 lbs. of ammonia, and both are reduced by the heavier dressing. Lime has greatly improved these plots, so that the sward has become more uniform, the poorer grasses are reduced, and the taller grasses, especially foxtail, have increased the hay yield. Interesting results were obtained on plot 11, full minerals and 660 lbs. ammonium salts. This heavy dressing failed to maintain the hay crop, which gradually fell from from 3 tons to 2, and latterly to 36 cwts.; this was due mainly to pluff grass (*Holcus*), which increased so much as to make up most of the herbage. The effect of lime on part of the plot in 1915 and 1920 was to thicken up the bottom and to produce a mixture of foxtail, tall oatgrass and pluff grass, the last much reduced. The effect of these heavier hay grasses has been to bring this plot up to be one of the high yielders. Part of this same plot ($11_{(2)}$) has received silicate of soda or water glass all the time, and this strongly alkaline substance has had much the same effect as lime when used with a large amount of ammonia and minerals. This plot maintained a 3 ton yield up to 1895, and though it has dropped nearly a ton, it is the second highest yielder on the past five years' averages.

VI. **Nitrate of Soda Plots.**—Three plots have received nitrogen in this form, namely—plot 17, nitrate alone 275 lbs., equivalent to 220 lbs. sulphate of ammonia; average yield for last fifteen years about 25 cwts.; plot 16, complete minerals with same amount of nitrate, yield 40 cwts.; plot 14, minerals with double amount of nitrate, the largest yield of all the plots, nearly 54 cwts. average for the last five years. The weakness of nitrate alone is evident, and the herbage is uneven and patchy though dark in

colour. Leguminosæ are deficient, but most of the grasses already mentioned are present, some of them abundant. Cocksfoot has gradually increased, and this along with the abundance of plantain and other weeds suggests a reversion to the poverty condition. The other two plots are first and third in yield of the whole series, and both have a good sole of bottom grass, that starts early in spring and produces a dark green tall herbage inclined to lodge at hay time. Foxtail is the most abundant grass on both plots, tall oatgrass increases with the larger amount of nitrate, and there is a considerable variety of other grasses. Yellow vetchling (*Lathyrus pratensis*) is the common leguminous plant, though there is some red and white clover with the smaller amount of nitrate. Lime has had no marked effect on these plots, thus supporting the view that nitrate is basic in its reaction, not acid like ammonium salts.

VII. **Farmyard Manure Plots.**—The common practice of manuring hay meadows with farmyard manure is illustrated at Rothamsted by three plots. A yield of 25 cwts. (average of fifteen years) was obtained with farmyard manure applied every fourth year since 1905, after a period, 1872 to 1904, of superphosphate, potash and nitrate of soda (plot 19). This average becomes 33 cwts. (plot 20) where since 1904 farmyard manure every fourth year is used, with superphosphate, potash and nitrate every other year. The yield rises to 37 cwts. (plot 13) where farmyard manure is applied every eighth year and fish guano in the fourth year between; up to 1904 this plot received minerals and ammonium salts every year. The plots are patchy and rather bare in spring, but come early in the years when the organic manures are applied. Grasses predominate, including most of the species already mentioned, and throughout the experiment foxtail and tall oatgrass have increased, sometimes also cocksfoot. The heaviest yield (plot 13) bears a strong, tall herbage, inclined to lodge and to destroy the bottom grass; the other two have a thicker growth of less heavy hay. The alternation of farmyard manures and mineral manures does not give the largest crop, but it seems to be a useful kind of hay, which, contrary to that on most plots, shows signs of increasing in recent years. Liming where tried has not had much effect.

General.—The lessons of this series of experiments are too numerous to be shortly summarised, but the following are of special importance:—It is unprofitable for enclosed land to leave it unmanured, or to treat with one-sided manuring, for both lead to poverty of herbage. It is also clear that the foundation of grassland manuring is phosphates and to some extent potash. These alone will produce a satisfactory and constant grazing, though they do not encourage the bulkier grasses that give hay. It appears that the high hay yields obtained by .4 to 6 cwts. of ammonia, and 2½ to 5 cwts. of nitrate of soda do not favour good grazing. In almost every case the great growth of rank grass has spoiled the bottom, though it is probable that if the aftermath was grazed the bottom would improve. Half the ammonia and about

1 cwt. of nitrate, besides being economical, would better suit the grazing herbage.

Another part of Dr Brenchley's book deals with the behaviour of the more common plants, and some of these have already been mentioned. Bent (*Agrostis vulgaris*), always an intruder into good grass, is shown to increase with starvation, with farmyard manure, and with some other manures. It is decreased by superphosphate, and is kept in check by most manures that encourage the taller grasses. The combination of cocksfoot, pluff grass and sheep's fescue is specially noted as antagonistic to bent. Lime in most cases has reduced the bent. Sheep's fescue, with its various forms, has generally held its own as a bottom grass. In the hay analyses it is more conspicuous on the unmanured and poverty ammonium plots, and is kept down when the taller grasses are encouraged. Pluff grass or Yorkshire fog (*Holcus lanatus*) may be regarded as a sign of one-sided nitrogenous manuring, or of lack of potash. It is kept in check by nitrate of soda with minerals, and the marked effect of both lime and alkaline silicate of soda has already been noted. Sweet vernal grass (*Anthoxanthum odoratum*) has held its own persistently, being especially encouraged by ammonium salts, but suppressed where the taller grasses are encouraged. Foxtail (*Alopecurus pratensis*) occurs in every plot, and responds well to good manuring, provided lime is maintained. Another useful hay grass, tall oat grass, is encouraged by heavy complete manuring, and to some extent by lime. Red clover is rather low in growth, hence does not show up well in hay analysis; it appears to be encouraged by keeping down the nitrogenous manures. White clover is present on these plots, but hay analyses give little information about it. The chief leguminous plant is yellow vetchling (*Lathyrus pratensis*), which with mineral manuring grows in dense masses, but is much reduced by starvation or nitrogenous manures. Bird's-foot trefoil (*Lotus corniculatus*) is often conspicuous on the poverty plots. Some of the more common "weeds" have already been referred to, and it only remains to add that these are typically weeds encouraged by hay-making, and need not be weeds where the ground is also grazed.

THE NUTRITIVE REQUIREMENTS OF POULTRY.

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AND

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INTRODUCTORY.

DURING the past two years the Rowett Institute and the three Scottish Colleges of Agriculture have been carrying out joint investigations on certain problems connected with the feeding of

poultry. It has now been decided to publish a short series of papers giving results which it is thought may be of value as a guide to poultry keepers. Before dealing with the experimental work, it may be of interest in this preliminary note to state briefly the reasons for undertaking this joint work and the arrangements under which it has been carried out.

During the past few years there has been an accumulation of knowledge which has thrown new light on those fundamental principles of nutrition which are the basis of all successful feeding practices. Most of this recently acquired information, however, has been obtained through experiments on animals, usually small animals, kept under laboratory conditions and fed on highly artificial diets which would not be used in practice, and the results are, therefore, not directly applicable, in their entirety at least, to farm animals kept under practical conditions. Before the results of these researches can serve as a guide to those engaged in the industry, they must be subjected to the test of practical experiment.

In poultry feeding, there is a wide field for practical experimental work of this nature. Chickens are now being commonly used for laboratory feeding experiments, and some of the results of these academic researches seem of potential value. An extension of practical experimental work based on the results of these researches is needed to test whether the knowledge acquired is of economic value, and if so, to find out by what means it can best be applied in practice.

At the Rowett Institute, research work has been carried on since 1920 on the vitamin requirements and the mineral requirements of poultry and on the relative value of different proteins for growth of chickens. The work has been carried out with small groups of birds kept under laboratory conditions and fed on artificial diets. To enable this work to be carried on to the stage of practical test and demonstration, it was arranged by the Board of Agriculture for Scotland that the three Scottish Colleges of Agriculture, each of which has a poultry department run chiefly for teaching and demonstration purposes, should co-operate with the Rowett Institute in conducting investigations in poultry feeding.

The method of conducting investigations has been as follows:—The experiments to be carried out are agreed upon at a conference of the Heads of the Poultry Departments of the three Colleges and representatives of the Rowett Institute. The experiments are then carried out at the different centres. This co-operative method secures that in all the investigations three or four feeding experiments of the same nature are carried out simultaneously by different observers at different centres. At the end of the experimental periods another conference is held at which the results are discussed and further experiments outlined.

This co-operative method of research has the following advantages:—It enables the information possessed by the research workers, either at the Rowett Institute or other Research Institutions in Scotland, and the knowledge of the practical experts at the

Colleges to be pooled, both in devising experiments and in drawing conclusions from the results, which, if uniform at the three or four centres, can be received with a degree of confidence. By taking advantage of all the existing facilities it has been possible to carry out the experimental work without an outlay of capital expenditure on a new poultry experimental station.

In this issue of the *Journal* a full account is given of the results of experiments to determine the effects of the addition of cod liver oil to poultry feeds. In subsequent issues results of experiments with yeast, with food-stuffs rich in the anti-scorbutic vitamin, and with mineral mixtures will be dealt with.

THE EFFECTS OF ADDING VITAMIN-RICH SUBSTANCES TO NORMAL RATIONS FOR POULTRY.

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I.—THE FAT SOLUBLE VITAMIN OR VITAMIN A.

During the past few years poultry keepers have been advised to supplement their rations with cod liver oil, yeast, or certain proprietary food-stuffs, on the grounds that the vitamins contained in them promote growth or increase egg production. The evidence in support of the claims made for the vitamin-rich substances, however, is based chiefly on the results of laboratory researches carried out with foods and under conditions which have no parallels in actual practice. As already mentioned, the results of such researches cannot always be directly applied in practice, and it therefore seemed desirable to determine by means of experiments with poultry kept under ordinary conditions and fed with commonly used rations, whether the use of these vitamin-rich substances gave results of economic value. A series of joint investigations for this purpose was therefore undertaken by the Poultry Departments of the Rowett Institute and of the three Scottish Colleges of Agriculture. The present article deals with the effects of the vitamin or vitamins in cod liver oil. This oil is largely used in experimental work as a source of the "fat soluble vitamin," and its use in practice has been advocated on account of its richness in this food factor.

Previous Work.

Before dealing with the records of the present investigation it may be of interest to give an idea of the nature of the results obtained in previous work on the requirements of poultry for the fat soluble vitamin of cod liver oil. Practically all the recorded work on this subject deals with growth experiments.

Hart, Halpin and Steenbock (1917), as the results of experiments carried out on Rhode Island Red chickens, concluded that "the corn grain, fortified only with its endosperm proteins and

calcium carbonate, suffices for growth and the continued maintenance of this species . . . . it is apparent that the corn kernel can supply adequately the vitamin demand (both fat soluble and water soluble) of growing and reproducing chickens." They state that even after eight months' use of this ration the birds continued to thrive. In this experiment, there was no possibility of a supply of fat soluble vitamin from any source other than the corn, as the birds were confined in wire cages with shavings as litter and had distilled water to drink. From the results of this experiment it would appear that corn (*i.e.*, maize), if fed in sufficient amounts, contains an ample supply of the fat soluble vitamin for the growth of poultry. In a later paper, however (1922), these same workers report that they were unable to rear chickens on a ration of nine parts of white corn, two parts calcium carbonate (chalk) and one part sodium chloride (common salt), with skimmed milk *ad lib.*, but when cod liver oil was added to the extent of 5 per cent., "excellent and uniform rates of growth were obtained." In another experiment, they tested the value of butter fat, which is one of the richest sources of the fat soluble vitamin. They found that with 15 to 20 per cent. of butter fat in the ration, as the only source of fat soluble vitamin, and with other nutritional factors provided, chickens fail to make normal growth. They estimate that the chicken requires more fat soluble vitamin than the rat, and conclude that the chicken requires a liberal supply of the vitamins of cod liver oil during its most active period of growth.

Emmet and Peacock (1921) state that chicks fed on a ration without any vitamin A. showed a number of pathological symptoms including oedema about the eyes, followed by an ophthalmic condition simulating xerophthalmia; but the facts on which the statement is based are not given.

Mitchell, Kendell and Card (1923) experimenting with Rhode Island Red chickens, found that on a ration of white corn, tankage and yeast, leg weakness developed, but no obvious abnormalities of the eyes could be detected. A similar condition developed when yellow corn was substituted for white corn, though the symptoms of malnutrition took longer to appear. The addition of cod liver oil to the ration, to the extent of 2 per cent. prevented these symptoms. These workers conclude: "As regards practical poultry husbandry, it seems, therefore, that the only vitamins that need be considered in the balancing of rations for growing chicks are Vitamin A., the requirement of which is so intense that the cereal grains must be supplemented by feeds richer in the vitamin, and possibly the antirachitic vitamin. Yellow corn in all probability contains a greater concentration of vitamin A. than wheat, oats, rye or barley, and yet evidently its vitamin content needs supplementing, even when it constitutes the major portion of the ration of growing chicks."

Sugiura and Benedict (1923) studied the significance of the fat soluble vitamin in the nutrition of pigeons. They used rations which were complete with regard to all the known constituents of

food, including minerals, but which contained no fat soluble vitamin. They found that: "Pigeons on a diet of sufficient caloric value, even though the diet lacks fat and fat-soluble vitamin, may maintain excellent condition, and may produce fertile eggs and rear healthy squabs. *Hence fat-soluble vitamin is not essential in any stage of avian nutrition.*"

Hoet (1923) working with pigeons confirmed these results.

The findings of these various workers are rather contradictory and confusing. The only conclusion that can be drawn, is that the addition of cod liver oil to certain ill-balanced rations fed to chickens in close confinement is markedly beneficial. There is nothing to show that, on a ration well balanced with regard to known constituents of food, chickens would not thrive without cod liver oil. Indeed, the results of Sugiura and Benedict strongly suggest this. These were the only workers referred to, who used a mineral mixture that was likely to meet the mineral requirements of growing chickens, and in their experiment the birds throve without the vitamins of cod liver oil. Nor is there any evidence to show that the addition of other oils than cod liver oil to the rations used by those workers, who noted beneficial results from its use, would not have been followed by a like beneficial result. Some of us (J.B.O., A.C., M.M.) have noted beneficial results on feeding linseed oil to chickens on certain artificial diets.

The conclusion of some of those workers that chickens have an intense requirement for the fat soluble vitamins of cod liver oil would not seem to be warranted without more conclusive evidence. There is at least justification for practical experimental work to determine whether ordinary mixed rations require to be supplemented with cod liver oil to supply a need on the part of the growing chickens for fat soluble vitamins.

With regard to egg production it would seem reasonable to suppose that a generous supply of fat soluble vitamin might be necessary. The yolk of egg is rich in this factor. It might be assumed, therefore, that the addition of a vitamin-rich substance, such as cod liver oil, to an ordinary ration would stimulate egg production. Unfortunately there is very little evidence, in the scientific literature at least, on this subject.

Present Investigation.

The investigation recorded here was carried out at the Colleges of Agriculture at Aberdeen, Edinburgh and Kilmarnock, and at the Rowett Institute, experiments of the same nature being carried out simultaneously at the four centres.

The rations in common use at these centres were used as the basal rations. Some of these rations contained fish meal as an ingredient. This feeding stuff, though containing some oil, is devoid of vitamins, as these are destroyed by the method of manufacture. Indeed, Bohstedt, Hunt, Winter and Miller (1923) have tested fish meal for vitamins, and found that it is so devoid of them that they advocate the use of this material in making up

basal rations which it is desired to have free from fat soluble vitamin.

In all the experiments care was taken that the birds in the different pens were comparable as regards breed and age, and were closely related.

The experiments were devised to test the effect of the addition of cod liver oil to practical rations on (A) Growth, (B) Laying, and (C) Hatchability.

(A) **Growth Experiments.**—In these experiments the caloric (fuel) value of the cod liver oil was balanced, in the control pens, by an equal amount of linseed oil which is deficient in fat soluble vitamin, so that a vitamin rich oil was tested against an oil with little or no vitamin. Experiment III. included a third pen on the basal ration without the addition of any oil.

Three experiments are recorded, one carried out indoors with twelve chickens under laboratory conditions, one with twenty chickens on an outside run of bare earth, and one with 210 chickens with a run on grass. In the first, 5 c.c. of cod liver oil per bird per day was given, *i.e.*, about 5 per cent. of the total ration; in the second, 1 c.c., and in the third, ½ c.c., rising to 1 c.c. Information was, therefore, got on the influence of the oil fed under different conditions of accommodation and in different amounts.

In experiments I. and II., to prevent any possibility of the result being complicated by deficiency of any other vitamin, vitamim C. (*antiscorbutic*) was provided by the addition of 2 c.c. of swede juice or orange juice per bird per day. This, however, was found to be unnecessary, and was omitted in subsequent experiments, as experiments run concurrently with those recorded here proved that poultry do not require vitamin C.

Experiment I.

Rowett Institute (Miss NORTH).

In this experiment there were two pens, each with six Leghorn chickens. Each pen had a cage 6 feet by 4 feet, with a wooden floor, and sawdust as litter. The cage was kept indoors in a well lit room, but the birds were not exposed to any direct sunlight.

The ration was as follows:—

Mash.	*Proportions.*	*Grain.*
Maize	4	Oats and wheat.
Bran	4	...
Oatmeal . . .	4	...
Fishmeal . . .	2	...
Bonemeal . . .	1	...

Limestone grit and water were always available, and the birds were given 2 c.c. swede juice per bird per day.

Pen I. had 5 c.c. cod liver oil per bird per day added to the mash, and Pen II. an equal amount of linseed oil.

On the fiftieth day the cockerels, two in the cod liver oil pen,

and three in the linseed oil pen, were removed. The pullets were continued on experiment until the ninetieth day.

The following table shows the gains in weight, in grams, of the pullets :—

TABLE I.

	Initial Weight.	After 90 Days.	Average Gain per Day.	Average Gain per Bird per Day.
	Grams.	Grams.	Grams.	Grams.
Pen I. (C.L.O.)	420	1085	7·4	8·6
	325	1145	9·1	
	400	1170	8·6	
	500	1332	9·2	
Pen II. (L.O.)	430	1275	9·4	10·7
	572	1552	10·9	
	560	1639	12·0	

The average gain in weight of the cockerels for the fifty days was 13·1 grams in the cod liver oil pen, and 12·3 in the linseed oil pen. All the birds were in good condition at the close of the experiment.

Experiment II.

East of Scotland College of Agriculture (Miss NEWBIGIN).

Here there were two pens, each with ten Anconas, in houses with outside runs of 220 square yards, on bare earth.

The ration was as follows :—

Mash.	*Proportions.*	*Grain.*
Bran	12	Wheat and maize.
Gr. oats	12	...
Sharps	12	...
Fishmeal	2	...
Dried yeast . . .	1	...
Maize meal . . .	1	...

Limestone grit and water were always available.

Pen I. received 1 c.c. cod liver oil per bird per day, and Pen II. an equal amount of linseed oil.

The following table shows the gains in weight in the two pens. One of the birds in Pen I. was accidentally killed, so that the averages are from nine birds in Pen I. and ten in Pen II. :—

TABLE II.

	Initial Weight.	Weight after 90 Days.	Weight after 230 Days.	Average Gain per Bird per Day : 90 Days	Average Gain per Bird per Day : 230 Days.
	Grams.	Grams.	Grams	Grams.	Grams.
Pen I. (C.L.O.) .	615·7	1475·8	1754·8	9·6	5·00
Pen II. (L.O.) .	613·8	1438·6	1773·4	9·2	5·04

All the birds were in good condition at the end of the experiment.

Experiment III.

West of Scotland College of Agriculture (MISS KINROSS).

In this experiment, there were three pens each with seventy white Leghorns, seven days old at the beginning of the experiment. Their rations consisted of seeds and cereal grains or cereal products with, in addition, milk for the first fourteen days, and thereafter fish meal.

Pen I. received $\frac{1}{8}$ c.c., rising at the end of the sixth week to $\frac{1}{2}$ c.c. cod liver oil per bird per day. Pen II. received an equal amount of linseed oil. Pen III. received no oil.

The following table shows the gains in weight :—

TABLE III.

	Initial Weight.	After 48 Days	Average Gain per Day.	No. of Birds Died.
	Grams.	Grams.	Grams	
Pen I. (C.L.O.).	31·1	342·4	6·5	4
Pen II. (L.O.) .	34·0	365·1	6·9	2
Pen III. (No Oil)	34·0	367·9	7·0	1

At the close of the experiment the birds were all in good condition. On the whole, those in the group receiving no oil were most uniform in size and showed the best plumage.

DISCUSSION OF RESULTS OF GROWTH EXPERIMENT.—Table IV. gives a summary of the results of the growth experiments.

TABLE IV.

	Average Initial Weight.	Average Final Weight.	Average Gain per Bird per Day: 90 Days.	Average Gain per Bird per Day: 230 Days.
	Grams.	Grams.	Grams.	Grams
Rowett Institute—				
C.L.O. . .	411	1183	8·6	...
L.O. . .	521	1489	10·7	...
Edinburgh—				
C.L.O. . .	615·7	1475·8	9·6	5·00
L.O. . .	613·8	1438·6	9·2	5·04
Kilmarnock—			*48 days*	
C.L.O. . .	31·1	342·4	6·5	...
L.O. . .	34·0	365·1	6·9	...
No Oil . .	34·0	367·9	7·0	...

The results confirm the preliminary report published by the writers in this *Journal* in July 1923. They afford no evidence that any beneficial result follows the addition of cod liver oil to rations such as are commonly used for chicks. Since these experiments were completed, Knox and Lamb of the Iowa State College have published (1924) the results of investigations on the

effect of the addition of vitamin-rich substances to an ordinary ration for chickens. They used cod liver oil and butter fat (to the extent of 2 per cent. of the ration) as sources of fat soluble vitamin.

The following figures show the influence of these additions on the rate of growth of the chicks :—

	Initial Weight.	Weight after 8 Weeks.	Grams Feed per Gram Gain.
	Grams.	Grams.	
Experiment I.—			
Controls, no oil	42·5	183·0	5·38
2 per cent. cod liver oil	40·5	169·0	5·55
Experiment II.-			
Controls, no oil	35	189	4·25
Cod liver oil	35	178	4·46
Butter fat	34	142	5·02

These writers conclude that: "The additions carrying a high percentage of the fat soluble vitamins did not produce better growth than the control lots. In all our work the fats (cod liver oil and butter fat) added did not appear to improve the ration. On the contrary, the chicks receiving fats appeared unthrifty, and did not make as good records as the controls." These results entirely confirm the results presented in this paper. They may also possibly throw some light upon the finding of Hart, Halpin and Steenbock referred to above, that, even when 15–20 per cent. of butter fat in the ration formed the only source of fat-soluble vitamin, the chicks failed to make normal growth. Probably the failure to grow was due, not to deficiency of vitamin, but to excess of fat.

(B) **Egg-Laying Experiments.**—The conditions under which the egg-laying experiments were conducted were, on the whole, similar to the conditions of the growth experiments.

Experiment IV.

Rowett Research Institute (Miss MOIR).

In this experiment there were four pens. In the first two there were twelve Leghorn pullets in each, in the other two, nine Leghorn pullets in each. The pens had grass runs of 250 square yards.

The ration was as follows :—

Mash.	*Proportions.*	*Grain.*
Bran	4	Equal parts wheat,
Sharps	4	oats and kibbled
Cr. oats	3	maize.
Gr. maize	3	...
Fishmeal	2	...

Pen A. received 5 c.c. cod liver oil per bird per day, and pen C. 5 c.c. linseed oil per bird per day. Pens B. and D. had no oil.

Table V. gives the results of the experiments.

TABLE V.

Eggs per Month.

	April	May	June.	Total	Average per Bird	Average Weight of Eggs[1]
						Oz.
Pen A. (12 pullets) (C.L.O.) .	254	205	112	571	47·6	2·09
Pen B. " " (No oil) .	255	254	129	638	53·2	2·19
Pen C. (9 pullets) (L.O.) .	189	188	100	477	53·0	2·23
Pen D. " " (No oil) .	185	184	100	469	52·1	2·22

Experiment V.

North of Scotland College of Agriculture (Miss MOIR).

In this experiment at Craibstone there were four pens, two with five Leghorn pullets in each, and two with five two-year-old Leghorn hens in each.

The ration was as follows : –

Mash.	*Proportions.*
Bran	2
Sharps	2
Maize	1
Fishmeal	1

The birds had 1½ oz. of grain per bird per day, and two c.c. of swede juice. Limestone grit and water were supplied *ad lib.*

Pens A. and C. received 5 c.c. of cod liver oil per bird per day.

The following table shows the results :—

TABLE VI.

Eggs per Bird per Month.

	Nov.	Dec.	Jan.	Feb	Total.	Average.	Average Weight of Eggs.[1]
							Ozs.
Pen A. (C.L.O.) . .	...	3·4	7·2	9·5	20·1	...	2·13
Pen C. " . .	...	3·2	6·8	11·1	21·1	20·6	2·25
Pen B. (L.O.) . .	1	2·2	6·5	12·0	21·7	...	2·25
Pen D. " . .	...	5·2	7·8	9·5	22·5	22·1	2·25

[1] In these tables the average weight of eggs are stated in ounces, as the 2 oz. egg is a familiar standard.

Experiment VI.

East of Scotland College of Agriculture (Miss NEWBIGIN)

The conditions of this experiment were the same as regards housing and feeding as in growth experiment No II. There were two pens with ten Ancona pullets in each. Pen A. received 1 c.c. cod liver oil per bird per day and pen B. an equal amount of linseed oil. The experiment ran from September to June.

Table VII. shows the results grouped from September to February, and from March to June.

TABLE VII.

Average Number of Eggs per Bird.

	September to February.	March 1 to June 8.	Whole Period.	Average Weight of Eggs
				Ozs
Pen A. (C.L.O.)	31·8	54·2	86·0	2·11
Pen. B. (L.O.) .	25·5	60·1	85·6	2·04

Experiment VII.

West of Scotland College of Agriculture (Miss KINROSS).

The first experiment at Kilmarnock was run from October 1922 to May 1923. There were three pens each with twelve Leghorn pullets, with grass runs of 390 square yards.

The ration was as follows : –

Mash.	*Proportions.*	*Grain.*
Bran . . .	3	Maize
Fishmeal . . .	2	Wheat
Sharps . . .	3	Oats.
Maizemeal . .	3	...
Crushed Oats . .	3	...

Pen B. received 5 c.c. cod liver oil per bird per day, and pen C. 5 c.c. linseed oil per bird per day. The results are given in Table VIII.

TABLE VIII.

No. of Eggs per Bird.

	Total—Oct.-Feb.	Total—Oct.-May.
Pen A. (No oil)	72·8	143·6
Pen B. (C.L.O.)	61·0	123·5
Pen C. (L.O.)	61·3	121·8

Experiment VIII.

West of Scotland College of Agriculture (Miss KINROSS).

As the results of experiments IV. and VIII. appear to indicate that the addition of either cod liver oil or linseed oil has an averse effect on egg production, it seemed desirable to obtain further evidence on this rather important point. The following additional test was therefore carried out in the winter 1923–24.

There were three pens with twenty Leghorn pullets in each pen.

The birds were selected from those used in Growth Experiment IV. and were kept in the "C.L.O.," "L.O.," or "No oil" group in which they had been during the growth experiment.

The ration was as follows :—

Mash.	*Proportions.*	*Grain.*
Bran	1	Maize
Thirds	1	Wheat
Cr. oats	1	Oats.
Maize meal	2	...
Fishmeal	2	...

Grit and water were always available.

Pen II. received 2 c.c. of cod liver oil per bird per day, and Pen III. 2 c.c. of linseed oil.

The egg-laying results were as follows :—

TABLE IX.

Eggs per Bird per Month.

	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Total.
Pen I. (No oil)	6·2	17·4	16·2	17·8	19·3	20·7	97·5
Pen II. (C.L.O.)	5·9	15·3	20·0	10·3	20·7	21·3	93·4
Pen III. (L.O.)	9·1	15·9	18·6	16·1	15·8	19·8	95·2

The following table shows the weights of the birds at the beginning and end of this experiment :—

TABLE X.

Average Weight in Grams of Pullets.

	Oct. 1.	March 31.	Average Gain in Weight.
Pen I. (No oil)	1560	1716	156
Pen II. (C.L.O.)	1544	1621	77
Pen III. (L.O.)	1584	1674	90

DISCUSSION OF RESULTS OF EGG LAYING EXPERIMENTS.—Table XI. gives a summary of the results of the egg laying tests. The pairs of figures given for each experiment are comparable, and the totals give an indication of the results.

TABLE XI.

Number of Eggs per Bird in the Egg Laying Tests.

A.			B.			C.		
	C.L.O.	L.O.		C.L.O.	No Oil.		L.O.	No Oil.
Exp. V.	20·6	21·6	Exp. IV.	47·6	53·2	Exp. IV.	53·0	52·1
Exp. VI.	86·0	85·6	Exp. VII.	123·5	143·6	Exp. VII.	121·8	143·6
Exp. VII.	123·5	121·8	Exp. VIII.	93·4	97·5	Exp. VIII.	95·2	97·5
Exp. VIII.	93·4	95·2						
Totals	323·5	324·2		264·5	294·3		270·0	293·2

Column A compares the effect of cod liver oil with that of linseed oil. In two of the experiments the egg production with cod liver oil was slightly higher than with linseed oil; in the other two it was slightly lower. The total result of these four tests indicates that the vitamin-rich cod liver oil had no more effect in stimulating egg production than the vitamin-deficient linseed oil.

Columns B and C show the effect of the addition of cod liver oil and linseed oil respectively to an ordinary ration. The amount of oil added in experiments IV. and VII. was 5 c.c. per bird per day, and in experiment VIII. 2 c.c. per bird per day. The results indicate that in these amounts the addition of oil tends to depress egg production.

The evidence seems sufficient to warrant the following conclusions:—

(1) If "fat soluble vitamin" is required for egg production an ordinary ration contains sufficient.

(2) The addition of cod liver oil to an ordinary ration is likely to depress rather than increase egg production.

Although some rather extraordinary statements have been made with regard to the value of fat soluble vitamin or vitamin A for feeding poultry, there is unfortunately little or no definite experimental evidence with which the above results can be compared. The only experiments conducted under exact conditions, which the writer has been able to find, are those of Sugiura and Benedict and of Hoet, who found that pigeons could be reared, and lay eggs on a diet completely devoid of fat soluble vitamin.

C. Hatchability Experiments.—To ascertain whether cod liver oil has any influence on hatchability, some of the eggs from the egg production experiments were hatched in incubators. Table XII. gives the results.

TABLE XII.

	No. of Eggs Set.	No. of Eggs Fertile.	Percentage of Fertile Eggs.	
			Hatched.	Dead in Shell or Addled
Experiment VI.—				
Pen A. (C.L.O.)	49	35	34·3	65·7
Pen B. (L.O.)	25	18	33·3	66·7
Experiment VIII.—				
Pen A. (No oil)	50	28	92·9	7·1
Pen B. (C.L.O.)	50	37	75·7	24·3
Pen C. (L.O.)	50	37	86·5	13·5
Experiment V.—			Percentage of Eggs Set.	
Pen A. (C.L.O.)	26	...	57·7	42·3
Pen C. ,,	26	...	84·6	15·4
Pen B. (L.O.)	26	...	57·7	42·3
Pen D. ,,	26	...	69·2	30·8

Unfortunately, in Experiment V., the observations made in the early part of incubation to determine the number of fertile eggs were not recorded at the time. The figures are, therefore, uncertain and are omitted.

There are considerable variations in the percentage hatched in the different experiments. These are doubtless due to factors concerned with the incubation. In each separate experiment the eggs from the different pens were hatched in the same incubator; the results are therefore comparable.

Though the results lack the uniformity of the egg laying tests, they suggest that the hatchability of the eggs is not increased by the addition of vitamin-rich cod liver oil to an ordinary ration.

Conclusions.

The experiments recorded here do not touch the academic question as to whether or not the fat soluble vitamin is essential for perfect nutrition in poultry, as no attempt is made to remove whatever vitamins may have been present in the rations used. The investigation was undertaken to ascertain whether or not the addition of a substance (cod liver oil) rich in fat-soluble vitamin to ordinary rations has any beneficial effect. The results seem to provide a conclusive answer in the negative. In the present experiments vitamin-rich cod liver oil had no more effect on growth or egg production than vitamin-poor linseed oil. If the vitamins of cod liver oil are essential, ordinary rations of the nature of those used in the experiments recorded here evidently contain a sufficient supply. Indeed, the results of the experiments in which a ration with oil was tested against the same ration without oil, seemed to show that unless the quantity used is very small, the addition of cod liver oil may have a depressing effect on egg production.

Cod liver oil has, of course, well-known therapeutic qualities, and the addition of it to the food of birds liable to get into a condition of malnutrition due to close confinement or an ill-balanced ration, might in many cases be beneficial. But the feeding of cod liver oil to poultry kept under normal conditions and receiving a well-balanced ration is not indicated.

FARM PESTS—BIRDS.[1]

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In endeavouring to place the subject of bird pests in its relationship to precise knowledge, I have been forced to admit an occasional variety of opinion and lack of unanimity regarding particular

[1] Articles in this series, dealing with Mammal Pests, commenced in the *Journal* in July 1922. The first article on Bird Pests appeared in the January number of the present volume.

birds, which makes dogmatism a dangerous game. Yet the point has now been reached when I must deal more specifically with the birds that cause damage to agricultural interests, and in so doing must run the risk of falling into the trap of which I have so carefully warned others. In view of the object of these articles, and in view also of the fact that the final (and executive) decision of what is to be regarded as a pest almost always rests with the farmer himself, I think it best, as well as stating my own opinion about the species generally regarded as pests, to give a balanced view of the two sides of a bird's activity, if it be fortunate enough to have two sides. So the farmer, knowing something of the good as well as of the ill, will be in a better position to judge for himself whether the local idiosyncrasies of the birds in his neighbourhood sway the balance the more to this side or that.

As much of the divergence of opinion regarding the standing of bird pests arises from different angles of view, it may be well to declare, as has already been done in the case of the mammal pests, that the sole criterion here must be an agricultural one, and that consideration of other interests, such as those of the game-preserver, lies outside the scope of these articles.

Following the plan adopted in discussing the mammal pests of the farm, I shall endeavour to classify the bird pests from an agricultural point of view, dealing in separate sections with the destroyers of live stock, of various crops each after its kind, of fruit and of forest, and finally indicating a few cases of indirect interference, where birds which do no evident harm yet play a part contrary to the interests of farming. The birds referred to in each of these sections will be mentioned not in any order of taxonomic classification, but approximately in order of their agricultural importance, which depends upon their numbers as well as upon their individual harmfulness.

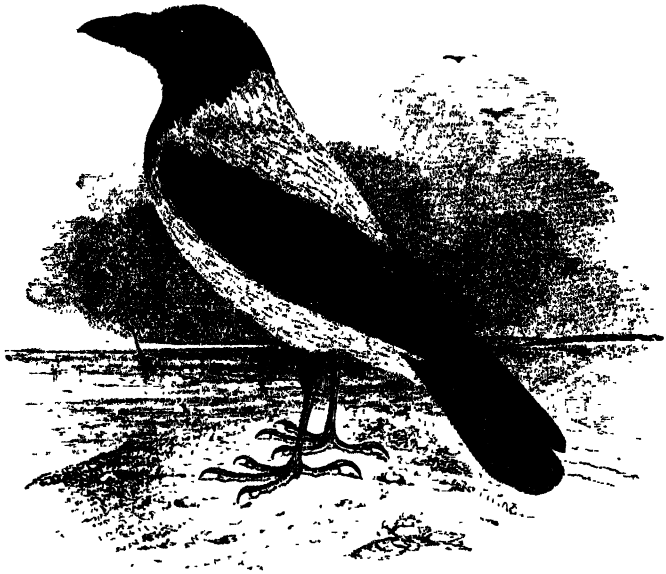
DESTROYERS OF LIVE STOCK.

The destroyers of live stock fall into two broad groups—those, mostly larger birds, which take their toll of sheep and lambs, and are the particular bane of hill pastures, and those lesser, but not less irritating pests of more civilised areas, which destroy poultry, chicks and eggs. The damage caused by the former lies more in the intrinsic value of their kill than in the extent of their destructiveness, while the reverse is true of the latter, where quantity rather than quality makes up the adverse balance sheet.

(1) DESTROYERS OF SHEEP OR LAMBS.—Taking the country as a whole it is probable that a very considerable sum of damage is done to sheep flocks by birds, for I have been impressed by the wide-spread complaints that have come to my notice of more or less regular depredations. These, of course, have been much reduced in number and in seriousness since the larger birds of prey have been wholly or almost wholly exterminated; and a further consequence has followed, for nowadays, with the reduction of the larger birds, the interference has ceased to be a danger threatening

flocks all the year round, and has become a seasonal matter. The surviving birds are in general unable to attack full-grown sheep, or even well-developed lambs, and their nefarious activities are consequently confined for the most part to the lambing season, when a young lamb or weakly ewe, or perhaps a heavy ewe overbalanced and on its back, become easy prey. Even in such cases it is seldom that the body of the sheep is devoured, but the notorious habit of the birds included in this category of picking out the eyes of the living animal causes as much loss as would be caused by a more whole-hearted attack.

It will be seen from the accounts that follow of the distribution of this type of pest, that the depredations tend to be confined to



HOODED CROW [1] [*Saunders*.

the wilder parts of the country, and that they involve in particular two kinds of agricultural areas, the ordinary inland hill pasture, and pastures near the sea-coast.

The Hooded or Grey Crow.—One of the most striking of the crow tribe, the hooded crow (*Corvus cornix*), stands apart from its relatives on account of the mantle of ashy grey feathers which clothes its neck, shoulders and back, and under parts. Otherwise it resembles the carrion crow in size, some 19 inches long from beak to tail, and in the colour of the remainder of its plumage, for the head, throat, wings, tail and thighs are black, with a greenish purple sheen.

The hoodie is the most common of the larger crows in Scotland, where it nests abundantly on the mainland north of the line of the

[1] The illustrations in these articles on Bird Pests are from Saunders' *Manual of British Birds*, and have been taken from the original wood-cuts by kind permission of the publishers, Messrs Gurney & Jackson, London and Edinburgh.

Tay and Clyde, as well as in the Islands; and it is by no means so rare in southern Scotland as some accounts suggest. Except in the north it seldom breeds in England, but England shares with Scotland a considerable winter influx due to migration from northern and central Europe. The nests may be found in almost any situation, usually on rocks or in trees, but occasionally even in bushes or on the ground. The eggs, four or five in number, are laid in March or early April.

The abundance of the hooded crow, rather than any habitual taste for live stock, renders it a serious pest. Its usual diet consists of carrion of any kind, of leverets, young birds, rats, shore refuse and birds' eggs. On the ground beneath a nest not many miles from

CARRION CROW. [*Saunders.*

Edinburgh, there were found on May 27, 1924, fifteen freshly destroyed eggs, including six greyhen, two grouse, two pheasants, two partridges, two duck and one curlew—a single day's hunting. The damage done to flocks is mostly confined to the lambing season, and at this period, in an infested area, the bird is "feared and hated on the sheep-runs"; for it is a bold marauder, and attacks not only young and sickly lambs, but even ailing or helpless ewes, first pecking out their eyes, and afterwards feeding upon the carcase.

The Carrion or Black Crow.—The carrion crow (*Corvus corone*), most likely to be confused with the rook, is easily recognised by its larger size, 19 inches from beak to tail, by its handsome black plumage, glossed on the upper parts with purple, and tinged on head, wings and tail with green, and by the forward directed feathers which cover its nostrils. Its ordinary note also is distinctive, a hoarse croak, very different from the "caw" of a rook.

The distribution of the carrion crow is very different from that of its close relative, the hooded crow. It is the common English breeding species, and while it is abundant in southern Scotland, it becomes rarer towards the north, until it reaches the limit of its range in Sutherland. In the West Highlands and in the Islands it is a rarity. In winter numbers visit our eastern counties from Europe, whither they return again in springtime.

Its feeding habits are very similar to those of the hooded crow. Its diet is omnivorous; it loves carrion, but does not disdain fresh meat; it devours insects of different kinds, as well as fruit and grain. It also destroys leverets, young game birds and eggs. A French observer, M. Leddet, counted in one day forty-five pheasant's eggs beneath a single nest at Rambouillet, and the case could be paralleled much nearer home. Its methods, however, are less aggressive, and the destruction it causes to sheep flocks is largely due to its attacks upon very young or weakly lambs, which it maltreats after the manner of the hoodie, a characteristic and well-known habit of its race:—

> "Crows on eager wings,
> To tear the flesh of captains
> And peck the eyes of kings."

That its activities cannot be ignored, however, is evidenced by the fact that complaints of its depredations have been received recently by the Board of Agriculture for Scotland from nine different counties, ranging from Dumfries, Lanark and Midlothian, north to Aberdeen, Banff and Inverness.

The Raven.—The largest and rarest, as well as the most handsome of our crows, the raven (*Corvus corax*), is distinguished by its size—about 24 inches from beak to tail—by its glossy black plumage with a fine purplish-blue sheen on the upper parts and on the hackled throat feathers, and by its long, stiff nasal bristles. Its cry is a hoarse croak, almost a bark.

Although some centuries ago ravens were common throughout the land, constant persecution has so reduced their numbers that in most parts of Britain the bird is now rare. In England it occurs only locally, and although it is more generally distributed in Scotland, it can be regarded as common only in the wilder parts of the Western and Northern Highlands and in the Islands. In the Outer Hebrides and the Northern Isles it is numerous; Macgillivray counted 200 at Pabbay, gathered over a stranded herd of grampuses, and Dr B. N. Peach informed me that on a similar occasion he estimated at 500 a flock on the mainland of Shetland.

The food of the raven bears a family likeness to that of the other large crows. Carrion it devours for preference, but live rabbits, leverets, rats and birds all bring grist to its mill. Fruits and grain contribute, but in minor degree, to its diet. Its rarity renders it a less general pest of live stock than its congeners, but where it is common, its strength of bill and voracious appetite make it a scourge of sheep flocks at lambing time. It is seldom

content with pecking out the eyes and tongues of lambs and disabled sheep, and its powerful bill is a fit instrument for piercing hides and tearing flesh to get at the entrails within.

The Economic Significance of the Larger Crows.—The history of the larger crows in Britian illustrates the curious change in the economic significance of animals which may be brought about by the advance of civilisation. In the case of the crows the change has been a complete topsy-turvy. Less than four centuries ago these birds of carrion were not only encouraged but were protected about our townships on account of their services in ridding the streets of garbage. In 1584 a German nobleman, Von Wedel, in passing through Berwick-on-Tweed, noted that "there are many ravens in this town which it is forbidden to shoot, upon pain of a crown's payment, for they are considered to drive away bad air"; and about a century earlier Capello observed in England that "the raven may croak at his pleasure, for no one cares for the omen; there is even a penalty attached to destroying them, as they say that they will keep the streets of the town free from all filth."

Nowadays persecution has replaced protection, and any degree of mercy that may be shown the crows is due not to a sense of their usefulness, but to a realisation of the fact that continued persecution such as they suffered runs the danger of bringing about their total extermination.

In so far as the crows confine their attention to carrion and the garbage of the village or seashore, they still contribute nothing but good to the human race:

> "The toil more grateful as the task more low;
> So carrion is the quarry of a crow."

Further in their favour must be added their very considerable destruction of pests such as rats, and of insects in so far as the insects are harmful.

But the other side of the balance is heavily weighed against the crows. Their destruction of lambs and disabled sheep is of itself enough to condemn them where they occur in numbers and practice such enormity, and to this must be added, as shall be shown in a future section, their thieving visits to the poultry yard and their occasional destruction of grain. There is only one plea that can be made for their retention, and it is the plea not of the practical man but of the lover of nature and of beauty: that because as original natives of the land they have some right of proprietorship, and because they add to the interest of the countryside, and in some areas and in small numbers do little ill, they deserve a remission of the full death penalty—they should be reasonably reduced in numbers where they are doing serious harm, but they should not be exterminated, nor brought within that proximity to extermination which in the long run means extinction.

Methods of Destroying Crows.—Of these, the gun is probably that most generally employed. But as a family, crows are not

easy birds to circumvent. They exhibit a wariness that avoids the near approach of a suspected person, and a cunning that enables them to steer clear of traps. It has been stated, however, that the raven is less cunning than its congeners, and is liable to fall into traps which would hold no attraction for them.

The methods made use of for the destruction of adult crows, other than shooting, are the reverse of edifying; but such as they are, I mention them here. In France many crows are killed, particularly in time of frost or snow, by the use of paper cones, the inside of which is coated with bird-lime, and which contains a morsel of flesh as bait. The hungry and unfortunate birds insert their heads to reach the food, the paper cone adheres to their heads, blinding them and hampering their movements, and they are easily shot. In our own country the favourite device is a bait charged with strychnine or nux vomica; an irresistable bait being a hen's egg, the contents of which have been partially replaced by the poison. But the laying of such a poisoned bait in position where it could be dangerous to human beings or domestic stock is illegal.

The most humane and probably the most effective way of preventing the excessive multiplication of crows is to leave the adults alone, and endeavour to check the new generation at its source. This may be accomplished either by destroying nests and eggs at the time of incubation, or by destroying the young while they are yet weak on the wing.

The Golden Eagle.—Largest of all our birds of prey, the golden eagle (*Aquila chrysaëtus*) is little likely to be confounded with any of its commoner relatives. In the air it is distinguished by the grace and even grandeur of its movements, a majestic sailing far above the mountain tops, or a powerful deliberate flight controlled by a wing beat, the force of which causes the tips of the wings to curve upwards owing to the resistance of the air. On the ground and near at hand its great size is as apparent, an adult bird measuring only an inch or two short of three feet from beak to tail, while a wing, from tip of pinions to forward edge, measures two feet in length. The general colour is a rich brown, which may be very dark, suggesting the Gaelic name, "black eagle;" the head and nape are reddish buff, the underparts chocolate brown. It can be readily differentiated from the rare white-tailed eagle by the presence of feathering on the legs down to the toes, as well as by the dark brown of its bill.

The distribution of the golden eagle in Britain has undergone a steady restriction for centuries owing to the persecution to which the species has been subjected. Its range used to be a wide one: two hundred years ago it nested in Derbyshire, a hundred years ago it built its eyrie in the Cheviot Hills; but now the English birds are gone, and in Scotland the eagle is confined to the central and northern Highlands and to the islands of the Inner and Outer Hebrides. In recent years, thanks to a certain amount of protection given it, it has shown a tendency to increase in some parts

and even to settle in new localities. As such an extension of range we must regard the occurrence in 1921 and the preceding years of a breeding pair in a wild part of the Solway area.

The golden eagle as a rule builds its eyrie on a ledge of some steep crag, more rarely in an isolated pine tree. The eggs, generally two in number, are laid towards the end of March or early in April, and the hatching of the young is the signal for the commencement of the most serious of the old birds' depredations, for the voracious young have to be fed through an infancy which lasts for eleven weeks before they are able to take to the wing.

Economic Significance.—The eagle illustrates very clearly how economic status may depend not upon any intrinsic feeding habit of the bird, but upon the sort of environment with which man surrounds its place of habitation. In the deer-forests it is almost universally protected and encouraged, since its destruction of grouse, ptarmigan and mountain hares, lessens the danger of an annoyance to which the stalker is liable, the warning of the hunted stag by the disturbed movement of the smaller members of the deer-forest fauna. But on the grouse moor and on the sheep run the golden eagle is anathema.

It feeds upon carrion of any kind, and the greater portion of its live food is made up of mountain hares, though red grouse and ptarmigan also form a staple part of its diet. In the deer-forest a red deer calf may occasionally be taken, but it is in the neighbourhood of sheep pastures that the most serious damage is done. Here, especially if lesser prey be scarce, it may attack and carry off lambs, though it seldom interferes with adult sheep unless they be sickly or incapacitated. It is unfortunate in this connection that the lambing season in the wilder parts of the country falls within or near the time of the nestling eaglets, for much of the lamb stealing is due to the necessity of satisfying their ravenous appetites.

Sheep runs in the neighbourhood of an eyrie may suffer heavily, but "neighbourhood" in association with an eagle must be read in a wide sense, for the eagle is a far-ranging bird, and occasionally visits pastures many miles from its home. Mr Gray in his *Birds of the West of Scotland* recorded the case of a pair of eagles inhabiting Mount Hecla in South Uist, which almost daily (about 1870) were seen travelling across the Minch from Skye each carrying a young lamb to the eaglets. The distance is about twenty-five miles—a tribute to the strength as well as to the destructiveness of the "king of birds."

This notice of the activities of the golden eagle must read like an out-and-out condemnation of a bird unworthy of sharing good country-side with an honest shepherd. But I have already stated that numbers as well as habits must be taken into account, and here the farmer has good grounds for comfort. Eagles are now very rare birds in most parts even of wilder Scotland—a very different story from the state of affairs a century ago. Then in seven years (1819 to 1826), a couple of estates in Sutherland

accounted for 295 old eagles and 60 young and eggs; in three years (1831-34) the Duchess of Sutherland's estate brought to book 171 old eagles and 53 young and eggs; and even in a few parishes about Braemar in Aberdeenshire 70 eagles were slain in ten years in the latter quarter of the eighteenth century. The present decrease in numbers reduces directly the amount of damage done, but it has the further advantage of permitting the survival of a much larger stock of mountain hares and moorland birds, so that with a more abundant staple food supply the eagle suffers less temptation to encroach upon the farmer's stock. It is likely that the more intensive game preservation of modern times has a like effect upon the agricultural activities of the bird, the artificial increase of bird life tending still further to reduce the average stock-damage caused by any individual.

Under the present Acts for the protection of wild birds the golden eagle shares with other birds the protection of a close season from 1st March to 1st August, from all persons except the owner or occupier of land or his agent; but in many Scottish counties it is absolutely protected by local county orders. At the present time (June 1924) the following county orders prohibit the taking or killing of the golden eagle throughout the whole year and the taking or destroying of its eggs—Zetland, Orkney, Caithness, Inverness, Nairn, Banff, Aberdeen, Kincardine, Perth, Ayr, Dumfries and Kirkcudbright. In Argyll its destruction is prohibited during the close season and its eggs may not be taken, and in Sutherland only the taking of eggs is prohibited.

Where it is legal to do so, and desirable on account of the bird's depredations, the safety of sheep flocks can be to a large extent secured by the removal of the eggs from the nest as soon as they are laid, for the nestlings provide the great incentive for sheep-lifting, and this incentive removed, the old birds generally do little agricultural harm even though they continue to haunt the district. As a rule the bereaved birds do not lay a second time when the eggs are taken.

The White-Tailed or Sea-Eagle.—In a strict sense the white-tailed or sea-eagle (*Haliaëtus albicilla*), should have no place in a present day account of British farm pests, for since the relict of the last Scottish breeding pair disappeared from Shetland about 1918, the birds may probably be regarded as extinct as a resident species. But its presence fell so heavily upon the flocks of the West Highlands and Islands, and its extermination was due so directly to the hostility it aroused on this account, that it deserves passing notice.

As large as a golden eagle, it is readily distinguished from that species in adult life by its paler plumage, particularly about the head, and especially by its yellow (instead of blackish brown) beak, by the absence of feathering down to the toes, and by its white tail. In immature golden eagles, however, the basal part of the tail is white, so that on this account they are sometimes confused with the "white-tailed" species.

The sea-eagle, like its cousin, feeds upon small mammals, birds and carrion, but it also subsists largely upon fish. As a consequence its eyries were generally to be found on the ledges of steep cliffs along the sea-coast. Its destructiveness to sheep flocks has long been recognised. Brand, writing of Shetland about the opening of the 18th century, says: "There are also many eagles, which do great prejudice and hurt to the country; for the lambs they lift up in their claws, and take whole to their nests, and falling down upon the sheep, they fix one foot on the ground and the other on the sheep's back, which they having so apprehended, they do pick out their eyes, and then use the carcases as they please" (1701). In Orkney in 1806 a reward of three shillings and sixpence was paid for the killing of each of these eagles.

The rapidity with which man can sweep away the unfortunate that crosses the path of his economic prosperity cannot be better shown than in the case of the sea-eagle. Half-a-century ago Robert Gray wrote (1871): "Being a much commoner bird in Scotland than the preceding species [the golden eagle], the sea-eagle has never been at any time in the same danger of extinction," and he records that in seven years a single keeper shot on one estate in Skye fifty-seven eagles, and another in West Ross fifty-two in twelve years. Yet in half-a-century ruthless persecution has banished this once common species from the country.

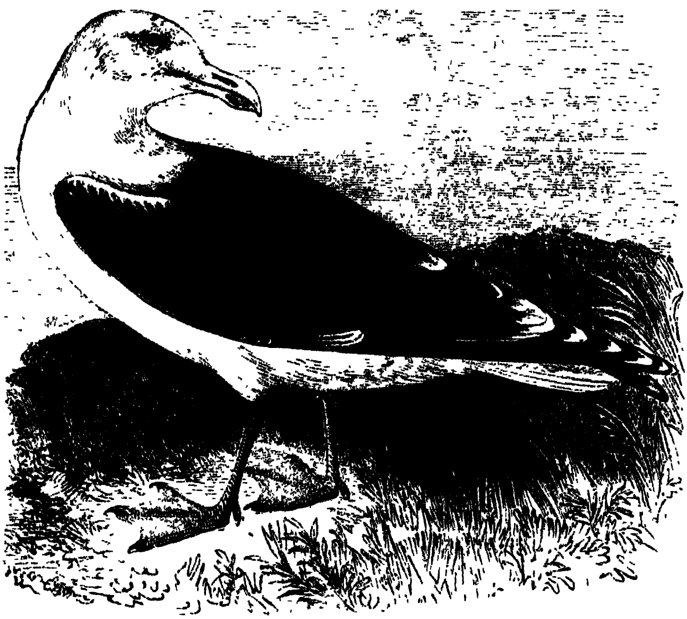
The Great Black-Backed Gull.—Last on our list of the birds that harm larger domestic stock comes the great black-backed gull (*Larus marinus*), placed here not because its evil deeds are negligible, but because it belongs to a group very different from the birds of prey and the "crawis, corbeis and ravenois foullis," and because it probably took to the habit which now condemns it at a much later date than they.

The great black-back is the largest of all our gulls, its length from beak to tail measuring 32 inches, and its wing 19 inches. Its plumage, distinct though it is, is scarcely more characteristic than the bird's size, for on the sea-shore it seems enormous contrasted with the commoner gulls, even the large herring-gull being dwarfed by its side. Immature birds are dappled brown and grey, like the young of other gulls, but the adult is distinguished by its great mantle of slaty black, which includes the back, and the greater part of the wings. The primary feathers of the wings are black with white tips, the remainder of the plumage snowy white, the bill yellow with an orange blotch on its lower part, and the legs and feet pale flesh colour.

As a common breeding bird, the great black-backed gull is peculiarly Scottish, for in England and Wales it can be regarded only as a local resident on the west and south-west coasts, and it is absent from the east. But in Scotland it is often abundant, and large colonies are to be found on the west coast and in the western and northern islands. In winter, it is to be found much more widely distributed along the shores of Britain, for its local numbers

are augmented by visitors from breeding places in more northern lands, which make a general southward trek after the nesting season is over. The winter distribution, however, has no bearing upon its agricultural significance in this country.

The nest, a rude assemblage of grass, seaweed and sticks, may be placed on a rocky ledge, but the birds seem to prefer the grassy tops of stacks, of isolated rocks or even of islands in fresh water lakes, and in such places the nest is little more than a hollow in the turf, scantily lined. The eggs, two or three in number, are laid in May or early June, and the young birds are able at an early age to leave the nest.



GREAT BLACK-BACKED GULL. [*Saunders.*

The size and strength of the great black-back make it a lusty feeder. In his excellent work on *The Birds of the British Isles*, Mr Coward gives a vivid description of its voracity: "All gulls are omnivorous, but the great black-backed gull prefers its meals to be of flesh, either recent or ancient. A dead rat, dog, or whale is alike acceptable to the 'corpse-eater'; where the carcase is there will the black-backs gather, keeping the smaller fry away. It will pounce upon and devour the 'cripple,' before the wild fowler can gather it, it ruthlessly slays its neighbours, the puffins and shearwaters, tearing out their entrails and leaving the rest for the rats; it has been known to bolt whole so large birds as redshank and little auk."

Did it confine itself to such a variety of diet, the farmer might ignore its presence, though the inhabitants of St Kilda loathe a

thief which harries the nests of the birds upon which they themselves largely depend for sustenance. Indeed, it might as a remover of carrion and general scavenger, even be looked upon as beneficial to mankind. But the great black-back has developed a habit of destroying young lambs, attacking them, as the crows attack, by first pecking out their eyes. It has even been known to assail helpless ewes in the same way. I have been much impressed by the unanimity with which farmers, especially on the west coast, condemn this species because of the harm it does to their flocks, and the evidence seems to me to indicate that the practice of maltreating lambs is becoming more common and habitual. Complaints on this score have been made to the Board of Agriculture for Scotland from several counties, extending even so far south as Ayrshire.

Under the Wild Birds Protection Acts, gulls are protected during the close season, from 1st March to 1st August, from all persons except the owner or occupier of land or his agent, but their destructiveness has led many counties to issue orders through the Secretary for Scotland, exempting several or all of the gulls from the operation of these Acts. In the following counties the great black-backed gull is exempted from all protection:—Zetland, Orkney, Inverness, Aberdeen, Kincardine, Forfar, Perth, Stirling, Wigtown and Dumfries.

DRIED MILK.

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A RECENT development of the dairying industry which is arousing wide-spread interest is the increase in the production and use of dried milk. Those more particularly interested in the trade in this country view this development with a certain amount of alarm. So far as this concern has reference to the importation of dried milk from other countries it is undoubtedly well founded. The development of the production of dried milk as a branch of the home dairy trade is quite another matter, and one which deserves the careful attention of all those who are interested in the increased production and use of milk. The recent increase in the use of dried milk is due to the improved methods of manufacture now in use, and there can be little doubt that, as these methods are further improved, the product will become more attractive and command a wider sale.

It is obvious that if it is possible to convert milk at a reasonable cost into a dry powder without affecting its food value to any serious extent, the dried product will have very considerable advantages. Reference was repeatedly made, at the recent Conference held in Glasgow for the formation of a National Dairy Council for Scotland, to the serious effects of the present high

rates of railway transport on the cost of milk. When we remember that over 87 per cent. of milk consists of water, it is obvious what a great saving would be effected if we had only to carry the "dry matter" of the milk on which its food value alone depends. A second consideration, viz., that dried milk is more easily kept in good condition for a long period than ordinary milk, and is thus more economical in use, is of importance, especially in the case of the small consumer. Dried milk can also be packed so as to reduce the risk of contamination to a minimum and it will also be shown that while the process of manufacture, as at present carried out, does not entirely sterilise the product, it at any rate greatly reduces its bacterial content and diminishes the vitality of such organisms as are left. It is thus easily seen that the future development of this branch of the industry is worthy of the most serious consideration.

The object of the present paper is to give a summary of the present knowledge of the properties of dried milk, and the results of an investigation into the quality and cleanliness of the dried milk now on the market. It does not deal in detail with manufacturing methods.

Preparation of Dried Milk.

Dried milk is prepared by two processes:—

(1) The milk is delivered in the form of a thin stream on to large revolving rollers heated by high pressure steam, the temperature of the rollers being considerably over 100° C. The water is evaporated and the thin crust of dried milk removed by means of a scraper.

(2) The milk is first concentrated by evaporation in vacuo, and is then sprayed under considerable pressure into a hot chamber where it meets a current of heated air; the evaporation of the water is practically instantaneous and the milk falls to the floor in the form of a fine powder.

As has already been mentioned, the drying process greatly reduces the bacterial content of milk, but it does not bring about complete sterilisation. The roller methods of manufacture are more effective in reducing bacterial numbers than the spray methods. The bacterological evidence at present available may be summarised as follows:—

(1) Figures obtained by different workers for the bacterial content of dried milk immediately after drying are given below:—

No. of Organisms per Gram.	*Process.*	*Authority.*
45·80	Hatmaker (Roller)	Kossowicz
70·300	" "	Delépine
10,000–15,000	Spray Method	"
Generally less than 1000	Hatmaker (Roller)	Supplee and Ashbaugh

(2) There is a great risk of recontamination in the process of sifting and packing and many of the high counts

obtained are due almost entirely to recontamination. Delépine found that the bacterial content of the packed and finished product was about ten times as high as that of the powder immediately after drying.

(3) Bacteria of fæcal origin, *i.e.*, those capable of producing gas from lactose, occur quite frequently in dried milk samples. Those found in dried milk appear to be mainly of the anaerobic sporing type, and probably resist the drying process in virtue of the fact that they produce spores. Their presence in considerable numbers indicates that the milk has originally been produced under insanitary conditions.

(4) Bacteria do not multiply in dried milk. On the contrary their numbers generally tend to fall off and to reach a more or less constant level after two to six months.

(5) There is no evidence that the development of an unpleasant flavour or aroma in dried milk is due to the action of micro-organisms; the percentage of moisture present is generally too low to allow of any activity by bacteria or moulds. The view has recently been advanced that the tallowy flavour in certain samples of dried milk is due to oxidation of the fat. Tallowy flavour is particularly pronounced in whole milk powders prepared by the spray method, and it is believed that this is to some extent accounted for by the fact that the particles of spray powder tend to enclose air bubbles, the presence of which hastens oxidation changes.

(6) There is general agreement that the Hatmaker method destroys the organism of tuberculosis or so weakens it that it becomes comparatively harmless. The only worker who has obtained positive infection with milk prepared by this process is Delépine. Inoculation of dried tuberculous milk into guinea-pigs produced lesions which appeared very slowly and did not during the course of the experiment produce a fatal result. Feeding experiments with rabbits failed to produce infection.

No work has so far been done on the effect of the spray process or the other roller methods on the organism of tuberculosis. It seems probable, however, that where, as is frequently the case, drying by this method is preceded by pasteurisation the organism will be destroyed provided the pasteurisation temperature is sufficiently high.

A considerable amount of work has already been done on the value of dried milk as a food, particularly as to its suitability for infant feeding. The general result of these enquiries was to show that, when the powder was prepared with proper precautions from fresh and clean cows' milk, and made up with the proper proportion of water, it provided a perfectly satisfactory food for infants and young people. Those who are specially interested in this side of the question are referred for further details to the results of an

enquiry carried out by the Local Government Board and published in 1918. (*Reports of Local Government Board on Public Health and Medical Subjects, New Series*, 110; *Food Reports, No.* 24, 1918).

PRESENT INVESTIGATION.

The dried milk on the market is partly produced at home and partly imported. The question of importation is an important one, as it has been shown that the quality of some preparations deteriorates on keeping, depending on the cleanliness of the milk used, the care used in manufacturing, and the method of packing and storage. At the same time it must be admitted that some of the New Zealand samples were among the best of those examined, showing that when proper care is taken the material can be kept for several months without deterioration.

The samples examined in this investigation were purchased at intervals during the summer of 1923 from as great a number of retail shops in the district as possible. In the cases where a bacteriological examination was made a sample was taken from the package or tin immediately on opening, and transferred to a sterile bottle.

Considerable variation occurred in the method of packing. Some preparations were packed in grease-proof paper and enclosed in air-tight tins; others were sent out in cardboard cartons, while the material supplied to bakers and confectioners was sold loose in bulk.

The samples varied slightly in colour and texture; they were mostly in the form of a rough powder, but in some instances were more of a flaky nature. The colour depended upon whether the dried milk had been prepared from separated or whole milk. In the former case, it was white or very slightly yellow in colour, while in the latter case the yellow colour was more pronounced.

All the samples had a rather "heavy" smell, while in some cases the smell was distinctly unpleasant and nauseous. The preparations were somewhat hygroscopic and absorbed moisture from damp air; the maximum amount taken up in this way was about 9 per cent.

They mixed with cold water with difficulty, but incorporated more readily with warm or hot water, but in no case was the mixture anything like so homogeneous as milk. In many cases a distinct curd as well as a layer of fat separated on standing. The taste of the mixture was rather insipid in the case of the good samples, while the others gave a mixture with a heavy, unpleasant taste and smell.

APPEARANCE OF SAMPLES AND MISCIBILITY WITH WATER.

(*The letters refer to the particular preparations*).

A. Full cream; fine yellowish powder; unpleasant smell and taste; the most objectionable of the full cream samples.

Did not mix well with cold water; a fatty scum appeared on the surface on standing, while a white curd was deposited. With hot water it mixed more easily; a considerable separation of fat took place, while curd was deposited on standing.

B. Full cream; yellowish in colour; not very finely powdered. Did not mix well with cold water, a curd remaining in suspension; mixed fairly well with hot water; mixture with water had insipid taste.

C. Separated milk; slight yellowish tinge; unpleasant, rather rancid odour. Mixed fairly well with cold water and well with hot water; mixture had an unpleasant taste.

D. Full cream; cream coloured and flaky in appearance; quite unlike other dried milks; pleasant taste rather like biscuits. Did not mix well with cold water, a curd remaining in suspension; mixed readily with hot water, with very little separation of fat; taste of water mixture insipid.

E. Full cream; slightly cream coloured in appearance; not a very pleasant smell. Did not mix well with cold water, a curd of coagulated protein separating in a short time. Mixed more easily with hot water, but not so readily as in samples D., F. and G; very slight separation of fat on standing; also of curd. Mixture with water had insipid taste.

F. Full cream; yellowish coloured powder with a pleasant taste and smell. Did not mix well with cold water, a curdy suspension separating; mixed fairly readily with hot water, with separation of fatty layer; whitish curd deposited on standing and cooling. Mixture with water had insipid taste.

G. Full cream with addition of milk sugar. A fine yellowish coloured powder, with a pleasant taste and smell rather like biscuits. Did not mix well with cold water, a curd remaining in suspension; mixed more readily with hot water but large fat globules separate on standing, and a certain amount of curd was deposited; with water had a rather insipid, mawkish taste.

H. Full cream; yellowish powder with a pleasant taste and smell recalling that of biscuits. Did not mix readily with cold water, but mixed better with hot, fat globules and a curd separating on standing. The mixture with water had rather an unpleasant taste.

I. Separated milk; a fine white powder with only a faint creamy colour; most unpleasant smell; very difficult to mix both with cold and hot water, a heavy curd separating in both cases. The mixture with water had a most unpleasant taste and smell.

Chemical Analysis.

An average of from 8–10 samples of each preparation were examined, and the results are shown in the following table:—

Full Cream.	Moisture.	Ash.	Protein.	Fat.	Sugar
A. . . .	4·28	5·31	26·85	25·43	38·82
B. . . .	3·84	5·24	26·88	25·72	56·85
D. . . .	3·16	5·54	25·38	26·90	37·49
E. . . .	4·39	5·43	25·51	26·28	37·59
F. . . .	2·78	5·68	26·71	27·20	36·45
G. . . .	2·54	4·80	24·08	24·07	45·12
H. . . .	6·11	5·53	25·91	23·72	36·29
Average (omitting G.) .	4·09	5·46	26·21	25·88	37·25
Separated Milk.					
C. . . .	7·92	6·99	33·45	0·42	47·04
I. . . .	8·54	6·82	34·34	0·50	48·28
Average .	8·23	6·91	33·90	0·46	47·66

In the case of the preparation from "Full Cream Milk" there was no suggestion that anything had been abstracted from the milk; in the case of sample G the makers stated that a certain amount of lactose had been added, and this was borne out by the analysis.

If the milks have simply been dried by evaporation, and nothing has been removed but the water, the relation between the different constituents is not affected. For example, if we assume that normal milk has the definite composition given below, it is possible to calculate the composition of the milk from which the various preparations have been made by using a factor derived from the following formula:—

$$\text{Factor} = \frac{\text{Sum of proteins and lactose in dried milk.}}{\text{Sum of ,, ,, ,, in normal milk.}}$$

The results of this calculation are shown in the following table:—

Reconstitution of Dried Milks.

	Fat.	Proteins.	Lactose	Ash.
Normal Milk	3·75	3·40	4·75	0·75
"Reconstituted" A. .	3·16	3·33	4·88	0·66
,, B. .	3·29	3·44	4·71	0·67
,, C. .	0·044	3·51	4·94	0·73
,, D. .	3·43	3·24	4·78	0·71
,, E. .	3·40	3·30	4·85	0·70
,, F. .	3·51	3·45	4·70	0·73
,, G.* .	3·76	3·76	7·05	0·75
,, H. .	3·11	3·30	4·76	0·72
,, I. .	0·05	3·51	4·93	0·70

* In this case, since the preparation contained added lactose, the factor was calculated from the fat.

It will be seen from the results of this calculation that the dried milks had been prepared simply by evaporation, and that there had been no removal of cream in the full cream samples.

BACTERIOLOGICAL EXAMINATION.

A certain number of the samples were also submitted to bacteriological investigation, the objects of which were—

(*a*) To determine the bacterial content of the various samples. This was done by placing definite quantities of the powders on whey agar at 22°C. and counting the colonies.

(*b*) To determine presence or absence of organisms of faecal origin as an index of the sanitary conditions under which the milk had been produced. It must be remembered, however, that certain of the organisms of this type may have been destroyed in the drying process.

The methods used were: —

(1) Determination of the smallest quantity of the powder which contained organisms capable of producing gas from lactose.

(2) Determination of the type of curd produced when 5 grams of the powder were reconstituted in 35 c.c. sterile water and incubated at 37°C. for 24 hours. Faecal organisms produce a blown (gassy) curd.

(*c*) To determine presence or absence of mould. This was done by observing the amount of mould growth produced from $\frac{1}{10}$ gram of the powder on whey agar.

RESULTS.

Samples B, C, H and I were supplied in paper bags—weighed out by the sellers. E was sold in cardboard cartons; D, F and G in tins. The tinned samples showed a much lower bacterial content and also contained much less mould than those sold loose, which would appear to indicate that the majority of the organisms in the latter are due to contamination in distribution. The separated milk samples C and I were very decidedly inferior to the corresponding full cream samples B and H respectively.

From the point of view of contamination with organisms of faecal origin the samples fall into two well-defined groups. Samples D, E, F and G were highly satisfactory. In no case did they show lactose-fermenting organisms in $\frac{1}{10}$ gram, while only two samples yielded a blown curd in the fermentation test.

Samples B, C, H and I were much less satistactory. Lactose-fermenters were present in $\frac{1}{10}$ gram, or less in seven cases, and eleven of the samples yielded blown curds in the fermentation test. These samples would, therefore, appear to be manufactured from milk produced under more or less unsanitary conditions.

Sample E differed somewhat from all of the others in that while it showed a high bacterial content, there was no evidence of the presence of faecal organisms. The sample also contained

comparatively little mould. A large proportion of the bacteria present were normal milk organisms, which leads one to suspect that the process of manufacture is different from that used in the other cases. This view is supported by the microscopic structure of the powder particles, which is what one would expect in a milk powder prepared by the spray process. This would account for the high bacterial content, for it has been shown that the spray process is not so efficient as the roller method in reducing bacterial numbers.

Sample G was undoubtedly the best from the bacteriological standpoint. This was a very well-known brand produced from particularly clean milk treated by a modified Hatmaker process.

Samples D aud F were only very slightly inferior to G: from their microscopic structure both appear to be of the roller type.

In view of the results obtained in this investigation, and also in those quoted in the summary above, one would appear to be justified in concluding that milk powders manufactured by the Hatmaker process and packed under sanitary conditions in tins are quite satisfactory products from the bacteriological point of view. It seems desirable, however, that more work should be done on the spray and roller methods particularly, in order to determine whether the organism of tuberculosis is destroyed when milk is dried by these processes.

The general result of the enquiry has been to show that, while the composition of the different products at present on the market is quite satisfactory, the conditions as regards cleanliness of some of the samples leave much to be desired. This contamination is due in some cases to dirty milk having been used and in others to contamination after the milk was dried. By proper care, both these sources of contamination could be avoided.

Great progress has been made in methods of drying in the countries which export dried milk at present, and it is evident that the competition of imported dried milk will have to be seriously reckoned with by the dairying industries of the future.

The large amount of analytical work involved has been carried out by Miss Jean H. Shiels, B.Sc., to whom we wish to express our indebtedness for her assistance.

STIMULUS FROM RURAL HOLLAND—II.[1]

J. W. ROBERTSON SCOTT.

Author of "A Free Farmer in a Free State (Holland)," "The Foundations of Japan: 6000 Miles in the Rural Districts," "Sugar Beet: Some Facts and Some Illusions," "The Land Problem," etc.

SCOTLAND is two-and-a-half times the size of Holland. Indeed, there is only one European country (if Luxemburg be excepted) smaller than Holland, that is Belgium. Denmark and Switzerland

[1] The first article appeared in the *Journal* for April 1924.

are both 3000 square miles larger than Holland. But the united populations of Denmark and Switzerland are not much more than equal to the population of Holland. The density of the population of Holland is twice that of Switzerland and Wales, and about thrice that of Denmark and Scotland. The density is less only than that of Belgium. But the Belgians are a manufacturing as well as an agricultural people. They have to be fed in some measure from abroad. Holland, an agricultural and trading country, is a large exporter of food.

The northern coast of the Netherlands lies in the latitude of the Humber. The southern borders of Zeeland and Brabant range with Maidstone. From Flushing and the west coast to the German frontier is about as far as from London to Bristol. The extreme length of the country is only 195 miles, say the distance between London and Exeter. The whole country is the size of the counties of Aberdeen, Inverness, Argyll and Dumfries. Although two-fifths of the people of Holland are rural, and the cultivated area is less than the area of the English counties which lie opposite it—Essex, Suffolk, Norfolk, Lincoln and Kent.

Holland is a social laboratory of which we might make a great deal more use than we do. Between Dutch and Scots there are notable differences in character, outlook and training. But there are probably more points of resemblance between Dutchmen and Scotsmen than there are between Scotsmen and any other European people. It would be an interesting subject for discussion whether the essential differences between the Dutch and the Scottish peoples are much greater than between the rural people of Aberdeen and Essex—before the Scots invasion. The resemblance between Dutch and Scots speech is also noteworthy. "Waar is mijn dochter?" any Scot understands. The special similarity between Scots and the dialect of the province of Friesland has often been pointed out. The Scots word "kye," for example, is perfect Frisian.

These considerations are appropriate in any Scots study of rural Holland. We are studying a country people not so unlike ourselves. Against our struggle with climate, and, in many parts, a poor soil, there has been the Hollanders' tremendous struggle with water, some account of which was given in a previous issue of this *Journal*. It is a point of similarity between the two countries not yet mentioned that in Holland, as in Great Britain, there is no duty on agricultural and horticultural produce. With two unimportant post-war exceptions, the general tariff of Holland is non-protective, that is, it is imposed for revenue purposes only. This is in no way a controversial point. It is a point that must be mentioned in any account of Dutch agriculture, for the best Dutch agricultural authorities invariably include the free trading system of the country as one of the causes of its rural prosperity. Under this system farmers' and market gardeners' requisites of all sorts have been obtainable at a moderate price. There has also been free

admission into one of the best markets in the world, luckily at Holland's very doors, the market of Great Britain. Dutch producers have been kept up to the mark—a score of agricultural authorities impressed this fact upon me—by the bracing influence of foreign competition. For example, Denmark, with almost the same advantages in access to the British markets as Holland, has also been an equally keen exporter of butter and eggs. It was a Dutch Minister of Agriculture who in a public speech gave me the title for my book about Holland, *A Free Farmer in a Free State.* "It is easy," he said, "for the State to do more harm than good. Farming which is not on a help myself basis is on an insecure basis. Farmers, if they know their business at all, know more about it than the State can know. We are for a free farmer in a free State." Further, under a free trading system, Holland has materially concentrated, as an authority explained to me, on "what it produces best."

The geographical situation of the Netherlands has been to her advantage, but the geographical situation of Great Britain is not inferior to that of Holland. Think, for one thing, how rich we are in inlets of the sea. The fact that the soil of Holland is in many parts of the country excellent, and, in some parts, not to be bettered, has been another factor in her success; but, as I showed in the last *Journal*, much of her soil is of her own making. An agricultural expert said to me: "I do not believe in the special fertility of the soil. The lighter the ground the more crops a year. It is manure that makes the soil fertile." The bulb areas were originally quite infertile.

Another favourable point has been the abundance of water, which the Dutch have so cleverly controlled as to make it not only a cheap means of transport, but, in the best agricultural and horticultural districts, a guarantee against drought.

There can be no question that the grit, industry, intelligence and adaptability of a people that has had to struggle to keep its head above water, physically and politically, has been one of the foundations of agricultural and horticultural progress. "We are what we are in agriculture and horticulture," said a Dutchman to me with some complacency, but also with truth, "because we are Dutchmen." I once noticed that some of the finest houses in Amsterdam were built by serene Hollanders at a time when their nation was fighting England, France, the Elector of Cologne and the Bishop of Munster together.

Those who remember the facts of Dutch history have some conception of the degree to which the provinces and cities of the Netherlands have been accustomed for centuries to gang their ain gait. The national instinct for self-government has greatly aided the cause of agricultural co-operation.

The utmost advantage has been taken by means of co-operation in purchase, manufacture and sale, and in the business-like study of foreign markets. "In growing," said one Dutch market gardener to me, "the small man has the advantage, and in selling

the big man; but in Holland the small man is able to co-operate, and therefore to sell well." Which is the whole truth about co-operation. For years one of the great agricultural federations of Holland has maintained a representative in London. After producing the best possible article, rural Holland has taken care to get the highest prices.

A high level of general education has made agriculturists and horticulturists accessible to and understanding of new agricultural, horticultural and commercial ideas, ready to learn from abroad, and appreciative of the advantages of travel. An admirable agricultural and horticultural education has been laboriously adapted to different classes.

There has been a long, skilful and painstaking agricultural and horticultural practice, due in part to the fact that minerals have played no part in the development of the kingdom. (There is no iron that matters in the country, and coal is found only in the Limburg peninsula, and has not been a product of much account until recent years.) There has also been a large use of artificial manures.

The progress which the man on the land has made in Holland is undoubtedly due in a considerable measure to the degree to which the nation, realising that much of its work must be supplying agricultural and horticultural produce to the foreigner, has given close attention to the subject, and while resisting a temptation to coddle and enfeeble by too liberal financial assistance, has granted funds to the Department of Agriculture as cheerfully as to the Army and Navy and the Waterstaat. The Department of Agriculture and Horticulture in its turn has shown a far-sighted activity in providing or helping in the provision of technical instruction of all sorts, and in judiciously encouraging rural self-help in every possible direction.

Finally, the people have lived economically. Their habits have been simple and frugal. Labour has not been dear, and this has been attributable chiefly to the low cost of living, due, every authority asserts, to there having been no restriction on imports. During the period corresponding with that during which there have been free importations of agricultural products into the Netherlands, the area under cultivation has risen by 50,000 acres, and there have been brought on the land 20,000 more horses, nearly a quarter of a million more cattle and half a million more pigs. Like the rest of the world, Holland is now suffering severely from the results of the war and the peace, but it would have suffered worse had it not stood on a foundation of agricultural and horticultural success up to the years of the great conflict. The author of a large German work on rural Holland, now unfortunately eighteen years old, noted, in regard to Dutch farmers, that "it is extraordinary with what intelligence and practical understanding they regard modern agricultural technique." "Nearly every farmer one meets," he writes, "be he in ever such a small way, can talk about phosphoric acid and nitrogen. He can tell you the proportion of

fat in the milk and he sprays his potatoes." There is ample evidence that what chiefly set Dutch farmers to use all their wits, and to seek and value scientific and commercial instruction was the gracious pinch of foreign competition. If they had not done their very best, and if the Ministry of Agriculture had not done its very best, the farmers and nurserymen of the Netherlands would have lost their foreign trade for good.

While in the 1881–90 period the Dutch grew 86,000 hectares of wheat a year, by 1907 they had cut down to 54,000 hectares a crop which they realised was being grown in competition with more advantageously situated areas oversea. On the other hand, in response to new opportunities, mangels and beet areas have been enormously increased. A district to which a few years' old guide-book would send visitors in order to see cheese-making has devoted itself for some time to market gardening. Elsewhere fishermen as well as farmers have become nurserymen. At a recent agricultural exhibition of Dutch produce in this country a Briton was heard to complain of the perfidy of the Dutch in putting cheese on the market at the time of the year when high prices are paid, "and then at low time of the year doing something else." Just so. Three years after the Dutch agricultural commissioner in London advised Dutch farmers to produce Cheddar, I found one province alone marketing £40,000 worth in a twelvemonth. The German writer I have quoted was struck by the intensiveness with which the work of the man on the land was carried on. "Even more intensively worked than the best soil is the meagre sandy soil. The results are really astonishing. . . . The greatest improvements in intensive cultivation are to be found in horticulture. The smallest areas are made to produce marvellous results. . . . Where the low-lying soil, carefully prepared, is not sufficiently fruitful, the market gardener covers in his whole area with glass. Where even that is not sufficiently productive, he builds hot-houses, and forces in them cucumbers and tomatoes like grapes."

This is the state of things in the formerly wind-swept Westland (referred to in my last article), but now full of wind-breaks. Stuff for our markets is not only grown there in fine style, it is disposed of wisely. Not the least interesting of the sights of the Westlands is one of those co-operative auction marts where the producer no longer seeks the merchant, but the merchant waits upon the producer, and the sales are made at the utmost speed by an ingenious device. At Loosduinen I found the market gardeners' auction mart straddling a piece of canal wide enough for a barge to be poled through. Here is a rough indication of the plan of the interior of the mart :—

Auctioneer.	Dial.	Clerks.
	Barge.	

Raised seats for merchants, each with his own electric button between his knees.

In comes the grower's barge filled with salads. Up go to the merchants, if they ask for them, one or two specimen lettuces,

thrown by lads belonging to the mart. The quantity is called out by the auctioneer—the quality is guaranteed by the Grower's Co-operative Society. The pointer of the dial, which has prices round its rim, is released, one of the merchants unobstrusively touches his button, the pointer stops, the sale is over, the amount is entered in the grower's books—previously left at the office for the purpose and now flung into the barge—the barge is poled out, and another barge appears with a fresh lot of produce. Just a minute and a half, I noted, had been occupied in selling a barge load of 2200 head of lettuce and 1000 cucumbers. The green stuff I saw sold shortly after midday would be down to the steamer by the evening and would be on some London luncheon-table next day. In a country where special cabbage trains are run, and a passenger train may be shunted to let an egg train pass, "perishable produce"—uniformly crated, however, and consigned in bulk—gets the attention it deserves.

The co-operative factories making butter, cheese and milk products are 627 in number. There are more than twice as many co-operative factories as non-co-operative factories. There are twenty co-operative potato-flour, nine co-operative strawboard, and seven co-operative beet-sugar factories and many mutual credit banks and insurance organisations. As late as 1906, Holland was an egg-importing country. Now it exports about 15,000 tons a year, a considerable part of them co-operatively. Co-operation has been not only a financial but a social success. Says an authority: "It has taken the farmers out of their isolation and raised them intellectually. They read more. Their interest in and love for their calling have been increased."

One of the triumphs of co-operation is the Farmer's Butter Control, which, like the Cheese Control, is now supervised by the Government. The Butter Control, invented by the Dutch creameries, is the best in Europe. On Dutch butter you can see impressed a label of thin, tough paper, printed with the national arms by the State printer. The things to notice about the label are (1) its perforation marks and (2) the number on it. When the thin piece of perforated paper is pressed on the butter by a special wooden stamp it seems in no way damaged. Try to take it off and it comes in pieces. Now for the number, say E37,222. This means :—

(1) E is the number of a consignment of 38 kilos.

(2) Books of Leeuwarden Control Station show receipt of labels, 30,001–50,000, from Government Dairy Station June 5, and despatch of labels 36,701–37,400 to creamery at Deinum, June 15.

(3) Book of sales at Deinum creamery shows sales to one Beck, July 5, of a cask of butter bearing the number 37,222.

(4) Register of Leeuwarden Control Station shows following record of a sample of butter taken by an inspector of the Association of Butter Producers at Deinum Control

Station, June 23–July 8: volatile acids, 28·9–29·5; refractometer, 44·5–44·7; water, 13·6–15·7.

Therefore a sample of butter of July 5 must give, if analysed, figures between these hyphenated numbers.

The official butter guarantee is protected not only by its own ingenuity but by law. Improper use of the guarantee is not a matter of a fine, but of imprisonment.

The Cheese Control is as clever a system as that of the Butter Control. The old pricking plan has been abolished. The mark borne by cheeses is not of paper but of casein. It is applied during the process of manufacture and grows in the cheese.

It is a new sensation to be in a country in which the people who rent or own the land in areas of 500 acres and more number about two dozen only, and the total number of holdings over 250 acres is no more than 216. Out of 209,302 holdings, as many as 182,011 are between 2½ and 50 acres. If the lowest unit of the tables were not 2½—that is a hectare—and areas of between an acre and 2½ acres could be taken into account, the result would show an even more remarkable preponderance of small holdings.

Of the 182,011 holdings between 2½ and 50 acres, more than half are owned by the men who work them. Indeed, more than half the cultivated area of the country in *geëxploiteerd doorden eigenaar*, is worked by the owner. Rural Holland came through the bad years more easily because the land was in the hands, not of a few, but of many, and so many with a free hand to cultivate as intensively as they had a mind. I was surprised in several districts by the number of farmers and market gardeners who had once been farm servants or labourers.

It is well worth noticing that in spite of the emigration to the towns, there is a growing population in the villages.

When all has been said about the help given to agriculture in the Netherlands by the Government, *Help U Zelf*, which caught my eye one day in a tramcar, is the motto of the farmer. Nothing was more refreshing to me in Holland than the independent hands-off attitude which the agriculturist so often displays towards the State. He did not call upon the Government to suppress butter-fakers. He started, as we have seen, the *Boter Controle*. Only when the Butter Control system had proved its worth did the State give it an official character. Government money has been more than once refused by Dutch agricultural bodies. It is many years ago since Professor W. G. S. Adams reported, after an investigation of the agriculture of the Netherlands, made in conjunction with Mr Fant, that "the feature which impressed us above all others was the strong spirit of self-reliance and self-help which was so evident in every branch." In a list of village agricultural societies I see before their names the satisfactory designation, *Zelfstandige* (self-standing).

But self-standing is one thing and individualism and sectarianism run mad is another. What is to be thought of rival organisations named the *Roomsch-Katholieke Boerenbond* and the

Christelijke Boeronbond—the Roman Catholic Farmers' Society and the Christian Farmers' Society? I came across an imposing cattle-cake factory the products of which were for the cows of Roman Catholics and approved believers of other denominations who subscribed to faith in "God, the Family and Individual Possessions." Sir Horace Plunkett's Irish solicitor, who declared at a propagandist meeting that butter would be made in his town on Nationalist principles or it would not be made at all, is outdone by the fanaticism which brought into existence a Roman Catholic Goat-Breeding Society! In practice, perhaps, the separate Roman Catholic and the Christian agricultural co-operation may not be so faulty as it sounds, at any rate as far as the farmer members' pockets are concerned. But we are increasingly learning that in the development of rural life there are other things to be taken into account besides pockets.

A thing that some visitors to Holland may not have seen is the cabbage stores. Only half the crop raised in the special cabbage country in North Holland is sold in the autumn. The rest is kept for a rise in price. Each grower has a shed in which perhaps thirty or forty thousand cannon-ball like cabbages can be stored. The cabbages are peeled of every possible piece of exterior leaf. In harvesting and in peeling they are handled with the greatest possible care. Graded into sizes and piled up with ingenuity, it is just possible to edge one's way down the gangway in the sheds between the four banks of cabbage. Usually there is another lot of cabbage upstairs. Remarkable to relate, these cabbages are examined one by one every fortnight or it may be twice a week or even daily. It all depends on the temperature shown on the shed thermometer. Any decayed piece of cabbage is deftly cut away in the fashion best calculated to prevent the injury spreading. The average loss is 10 per cent. I found one quality of cabbages weighing 10 lb. apiece. In the years before the war thousands of these cabbages were sold to Germany at 5d. apiece against a duty of 12 guineas a car load. There seems to be no such cabbage for sauerkraut. But some of the cabbage goes to France, Russia, Hungary, Spain, Portugal and Italy.

Onions are another crop that is ingeniously stored. The forms of the thatched structures vary, but the sides are usually made of battens at some little distance apart.

With regard to the cabbages, it is an interesting experience to be poled on a cabbage boat through the little canals which divide the seemingly endless series of cabbage fields. For the benefit of the cabbages the mud is constantly scooped out from these waterways. The level of the fields has therefore been raised to a degree which enables one to see cabbages in a new perspective. Like their owners, the horses which plough the cabbage fields go to and from their work in boats. No horses but those accustomed to navigation from their youth up could be made to take trips in boats about 15 feet long. It is only during ploughing, however, that a horse ever tumbles into the water.

This happens, of course, through the farmer at the stilts trying to plough the last foot of the headlands. If there is a chance of getting a bit more land the Dutch farmer must take it!

The phrase reminds me of what I saw in the heath country of the little eastern province of Overijsel, near Germany. On one holding the owner had made a hundred acres of grass land out of the wild. On a selected area the brushwood will be cut down. Then the area is fenced in. Next cattle are turned in. The ground benefits not only by the droppings of the stock but by the manure (mixed with sand) which is brought from the cowhouses, where a good layer of sods lies below the peat litter. It is not necessary to sow grass seed in carrying out this reclaiming work. The manure from the cowhouses is so full of hayseed that there is a sufficient crop of natural grass. The heather which at first was the predominating vegetation is overtaken in a few years by the good grasses. On 10 acres of such grass brought into existence in from two to four years, four cows can live throughout the summer. "To make new grass land has been a kind of sport with well-to-do men," some said to me; "but small men bring in an acre or two of heath now and then and do not count their labour." With this and a sentence addressed to me in another part of Holland, when I remarked the quantity of artificials applied, "Our land costs too much for us to be able to raise poor crops," I may close these notes of things seen and heard in a country a visit to which is so stimulating to every friend of rural progress. The Hollanders are not perfect. There are lots of the things in Holland, as in Britain, that could be bettered. But there are plenty of things there which are a lesson to us. Of these it is of service to write.

THE BIOLOGIST ON THE FARM.—No. XIV.

PROFESSOR J. ARTHUR THOMSON, M.A., LL.D.,

University of Aberdeen.

The Red Admiral's Sweet Tooth.—Many insects are very sensitive to odours. Thus Riley described an experiment in which the male of a moth was successful in seeking out a female a mile and a half away. But little is known of the degree of their sensitiveness to *taste*. This is due to the fact that the taste endings are usually confined to the mouth, where experimentation is virtually impossible. But Dr Dwight E. Minnich has shown that the beautiful black and scarlet Red Admiral butterfly, so familiar a sight on the meadows, has taste organs on the four terminal joints of the legs. These show a great sensitiveness to sugary solutions. When the butterfly is held so that the legs touch a piece of cotton saturated with sugary stuff, the butterfly moves its proboscis when the taste is felt. By altering the strength of saccharose solution

it is possible to test the sharpness of the Red Admiral's sweet tooth. The sensitiveness is as much as 256 times that of our tongue, and this is of course connected with the fact that the Red Admiral feeds on nectar, exuding sap, and juices of ripe and decaying fruit. The next time we admire a Red Admiral flitting past we may recall its subtlety of taste!

Cabbage Butterflies and Ichneumon-flies.—The caterpillars of the Cabbage Whites are often disastrously abundant. Another year they may be present in small numbers. One reason for this is to be found in the varying success of the check imposed by those Ichneumon-flies which lay their eggs in the caterpillars. When the Ichneumon grubs hatch out they devour the caterpillars from within. Dr G. Jegen found that out of 1360 pupæ collected in winter, 1216 were fatally ichneumonised, that is to say, about 90 per cent. Three kinds of Ichneumon-flies emerged—*Pteromalus puparum*, *Microgaster glomeratus* and *Pimpla instigator.* It is important not to collect or destroy the ichneumonised pupæ of the Cabbage Whites, for that means killing the ichneumon grubs and thus reducing the ranks of the useful Ichneumon-flies. The ichneumonised dead pupæ may be recognised by their immobility and darker colour. They are usually found in places more exposed and more accessible than those in which the non-ichneumonised pupæ occur. Dr Jegen raises a curious point. He found that the males of the Large White were 60 to 80 per cent. commoner than the females; and he thinks this may be because the Ichneumon-fly (*Pteromalus puparum*) prefers the caterpillars that are going to develop into female butterflies. But why should it? And, if it does, how does it discriminate?

Treated Rats and their Behaviour in a Maze.—Rather quaint experiments have been made in America by Dr E. Carleton Macdowell to discover whether white rats treated with fumes of alcohol would show any alteration in their powers of learning. The rats got big doses for twenty-eight days before and during their training with a maze—a labyrinth of the Hampton Court type. But they did not get a dose during the testing period until after their daily trials. The immediate effects of intoxication were thus eliminated. The rats tested were fifty-six to sixty-three days old. Those that had been treated took longer than their untreated brothers and sisters to get through the circular maze. They also tended to make more mistakes, but the figures here are not very conclusive. The effect of treating parents as well as offspring was not appreciable; on the other hand, a small but consistent modification of the maze behaviour was seen in the untreated offspring of treated parents. This was especially seen as regards the perfection of the behaviour. Seven rats from a normal pair did not appear to differ from five rats from the same mother and a treated father. We should like to have seen larger numbers of rats used in making these interesting but ticklish experiments. The author's conclusion is that "alcoholism in ancestors may modify the behaviour of untreated descendants."

Duration of Life and Constitutional Fitness.—There is not much precise information available in regard to the duration of life except in man, the fruit fly and a wheel-animalcule called Proales. Only in these three cases can we make *a life-table*, showing how many individuals born on the same day die from "natural causes" within particular intervals of time, and how many are surviving at the beginning of each age interval. It is a pity that we do not know more about this subtle quality of "duration of life," for Dr Raymond Pearl has established a strong probability in favour of the conclusion that in the fruit-fly, at least, it is determined by factors which are definitely inherited. Similarly there is a large body of evidence that duration of life is a heritable character in man. Pearl's further point is that duration of life may be regarded as a functional integration of all the elements that go to make up the *constitution* of an animal. An individual that is structurally and functionally of superior constitution will, in the long run, exhibit a relatively high degree of longevity. In fact, duration of life is a delicate and precise measure of constitutional fitness, and by selecting forms of long duration of life one might raise a very fine breed—very strong and with low juvenile mortality. Having got the breed, one would not necessarily let the individuals live long—if they were poultry for instance!

Comparative Mortality.—If duration of life is an index of a good constitution, and if it is a heritable character, we should like to be able to compare man's mortality with that of other organisms. Of course some device must be resorted to when we compare life-spans that are measured in days with life-spans that are measured in months or in years. It is plain that six months in a rat's life is not comparable to six months in a man's life. But mathematical biologists like Dr Raymond Pearl are quite capable of comparing the mortality of organisms whose total life-spans are widely different. In co-operation with Dr Carl R. Doering, Dr Pearl has compared man's mortality with that of a fruit-fly (*Drosophila*) and with that of a wheel-animalcule (*Proales*). Out of 1000 individuals starting together at biologically equivalent points in the life-span there will be at any subsequent biologically equivalent fraction of the span more survivors among the rotifers than among the men, and more survivors among the men than among the flies. This strikes us as an interesting and important line of inquiry.

Crowding and Length of Life.—A curious investigation has been made on the fruit-fly, *Drosophila*, by Professor Raymond Pearl and Miss Sylvia L. Parker. The inquiry was into the effect of density of population on length of life. This was tested by keeping from 2 to 200 flies in one-ounce vials. Observations were made on 12,382 flies, and it was found that the optimum density of population was certainly not the lowest. It was between thirty-five and fifty-five flies per one-ounce vial. It will be interesting to discover why this is so.

Wheels within Wheels.—We noted in No. XIII. (p. 155) that a tree may be a circle which many other life-circles intersect. Here is a good example recently reported by Drs A. Barbey and Ch. Ferrière from Switzerland. As everyone knows, the Scots Pine (*Pinus sylvestris*) is attacked by many insects, especially beetles. Very frequent are the galleries excavated by the Hylesine Beetle (*Myelophilus piniperda*), both as a grub and when it becomes a perfect insect. Inside the vacated galleries of this pine-beetle the Swiss naturalists found three different kinds of Hymenoptera. There were larvæ of a small burrowing wasp or Sphegid (*Passalœcus brevicornis*), which had been supplied by the mother insect with a living larder of paralysed Aphids. But there were also the rough cocoons of a Ruby-wasp or Chrysid (*Ellampus auratus*), and in the same gallery there were the silken cocoons of an Ichneumon-fly (*Lochetica pimplaria*). The larval stages of both of these were hostile to the wasp-grubs. Then there were marks on the tree showing that a woodpecker had been successfully investigating the Hymenoptera. Thus we have complex linkages—(1) the pine tree, (2) the pine-beetle, (3) the young wasps, (4) their Aphid-food, (5) the Chrysids, (6) the Ichneumon-flies, and (7) the woodpecker.

Inefficiency of Agriculture.—This is the heading of one of Dr E. E. Slosson's *Chats on Science* (1924), one of the most educative of popular expositions. His charge of inefficiency refers to the poor return that man gets from his fields. It is a poor steam engine that cannot turn into mechanical work at least 12 per cent. of the heat-energy in its fuel, but a green leaf is not able to catch and hold more than 1 per cent. of the radiant energy which the sun supplies. Dr H. A. Spoehr of the Carmel Coast Laboratory of the Carnegie Institution of Washington has calculated that an acre of ground receives in six hours of sunshine as much heat-energy as can be got by burning 16·4 tons of coal. In a growing season of ninety days the total income of energy would amount to 1476 tons of coal. Suppose the acre yielded 50 bushels of wheat, the energy equivalent of that is less than two-thirds of 1 ton of coal! We must not blame either the farmer or nature, but, as things are at present, "the farmer has received from heaven twenty-three hundred times as much energy as he has been able to market in the shape of food."

The Queen Bee's Store of Sperms.—Everyone knows that the queen bee on her nuptial flight is overtaken by an alert drone who inseminates her, and pays with his life for his success. He dies on the heights of sex. The sperms of the male pass into a reservoir or spermatheca connected with the lower end of the oviduct of the queen. There they remain as a store which is drawn upon to fertilise some of the queen's eggs as they are about to be laid—those eggs that develop into workers and queens. It is not to be supposed that the whole matter is as clear as one might wish, but let us emphasise one question only—How do the spermatozoa keep alive for months or years? Sperm-cells are so

minute that a hundred of them would not be crowded in a drop suspended from the head of a pin, but they are normally and typically very active cells, and they are without the stores of reserve-materials that are found in egg-cells. We do not wonder at egg-cells surviving for a long time in isolation, for they are naturally quiescent and they have a nutritive legacy, but how can sperms live for three or four years in the spermatheca of the queen bee? The answer seems to have been given by R. Courrier, who finds that the reservoir has an internal lining of confluent cells whose nuclei exhibit a secretory activity. At the expense of the nuclear substance, probably of the essential material called chromatin, granules are formed which rapidly increase in size and pass into the cell-substance or cytoplasm. There they undergo complete liquefaction, the results being diffused out into the cavity of the reservoir where the sperms lie. Courrier's view is that certain complex substances in the nuclei of the lining of the spermatheca are sacrificed to form the ration that keeps the sperms alive—it may be for years. Thus another old puzzle is brought nearer solution.

SCOTTISH AGRICULTURE IN THE CENSUS OF 1921.

JOHN M. RAMSAY, O.B.E., M.A.

THERE has recently been issued Volume III. of the Registrar-General's *Report on the Thirteenth Decennial Census of Scotland*, taken on 19th June 1921, which deals with Occupations and Industries.[1] A comparison will here be made between the Census figures now issued, so far as they relate to agriculture, and those for 1911. As the Annual Agricultural Returns taken on 4th June 1921 contained particulars of the labour employed on agricultural holdings, a comparison of the figures obtained through these two official inquiries, made almost at the same time, will also be of interest.

The distinction between occupation and industry is thus illustrated in the Report :—" If a cooper works for an employer whose sole or principal business or occupation is to manufacture barrels, such cooper would count as in the industry of Cooperage, while if the cooper works in the employment of a brewer or of a fish-curer, though he is still classed as a cooper in the occupation tables, his classification in the industry tables would not be Cooperage, but would be Brewing or Fish-curing." Thus the number of male persons returned in occupations of an agricultural nature exceeds the number returned in the agricultural group of industries by 10,679, or 6·7 per cent., a difference largely due to the inclusion under the former head of gardeners employed in private

[1] *Report on the Thirteenth Decennial Census of Scotland*, Vol. III.: Occupations and Industries; pp. xviii.+497; price, 30s. net.: to be obtained from H.M. Stationery Office, 120 George Street, Edinburgh.

gardens, who from an industrial point of view are returned under "Domestic Service." The difference in the case of women is much less, amounting to 536, or only about 2 per cent.

The information now given is much fuller than that given in the Report on the Census of 1911, the tables and lists extending to 497 pages, as compared with 239 in the earlier Report. Some of the new tables, such as those giving the distribution of persons in each occupation according to birth-place, are of little importance in agriculture, but a new feature of great value is the inclusion in Table II. of a statement of the numbers of married and single persons in each occupation.

The classification by industries has been much improved, and a most useful table (No. XIV.) shows how the industries are built up out of the various occupations, thus enabling the reader to trace such cases as that of the domestic gardeners already mentioned.

CENSUSES OF 1911 AND 1921—MALES.

The following table shows the numbers of males returned as engaged in agricultural occupations in 1911 and 1921 respectively. The figures for 1921 are taken from Vol. III. of the Census Report (Table II., page 12), but the order of the classes has been altered.

Class.	1911	1921	Increase + or Decrease −
Farmers	29,939	31,556	+ 1,617
Crofters	14,027	14,964	+ 937
Farmers' sons or other relatives assisting	11,619	3,768	− 7,851
Crofters' sons or other relatives assisting	5,008	2,288	2,720
Grieves and Foremen	7,250	5,230	− 2,020
Shepherds	9,041	7,442	1,599
Farm Servants—			
In charge of Cattle	13,806	11,243	− 2,563
In charge of Horses	35,475	37,397	+ 1,922
Not distinguished	22,260	26,360	+ 4,100
Total of above Classes	148,425	140,248	− 8,177
Nurserymen, Seedsmen, Florists	1,652	...	
Market Gardeners (including Labourers)	2,412	..	
Other Gardeners (not Domestic)	6,453	...	+ 8,223
Gardeners, Nurserymen, Seedsmen, Florists	...	15,635	
Gardeners' Labourers	...	3,105	
Fruit and Pea Pickers	...	34	+ 34
Drainage Superintendents, Foremen, &c.	...	29	+ 29
Land Drainage, Drainage Labourers	...	346	+ 346
Carry forward	10,517	19,149	+ 8 632

CENSUS OF 1911 AND 1921—MALES—*continued.*

Class.	1911	1921	Increase + or Decrease −
Brought forward .	10,517	19,149	+ 8,632
Agricultural Machine, Tractor— Proprietors, Managers, Foremen,	315	128	+ 236
Drivers, Attendants . . .		423	
Foresters, Woodmen . . .	3,621	4,078	+ 707
Labourers in Woods and Forests .		250	
Agricultural and Forestry Pupils (not in Colleges)	...	1,019	+ 1,019
Land and Estate Agents and Managers (not Auctioneers and Estate Agents)	...	828	+ 828
Estate Labourers	...	2,387	+ 2,387
Other Agricultural Occupations .	2,811	1,474	− 1,337
Total of above Classes	17,264	29,736	+ 12,472
Grand Total	165,689	169,984	+ 4,295

The apparent increase of 4295 in the grand total is illusory, owing to changes in classification. The classes of men engaged in what is ordinarily described as agriculture are unaltered, but the two new classes of gardeners, etc., substituted for the three old classes now include domestic gardeners, while several new classes are added.

Taking the first nine classes, for which a separate total is given, we find an apparent decrease of 8177. The residual class, "Other Agricultural Occupations," also shows a decrease of 1337. No doubt the latter decrease is accounted for by transfer to the new classes, and possibly this applies also in part to the decrease previously mentioned. It is suggested that an adjustment of 1000 should be made on this account. Mention should also be made of fishermen-crofters, who are placed in the Census under the occupation of Fishing, but who appear in the Annual Agricultural Returns as occupiers of crofts.

The total number of male persons engaged in agriculture, as returned in the Census of 1911, may be stated as follows :—

Total of first nine classes	148,425
Market gardeners (including labourers) . .	2,412
Others	2,811
Fishermen-crofters	3,879
Total	157,527
Or say	157,500

The corresponding figures for 1921 are as follows:—

Total of first nine classes	140,248
Market gardeners (including labourers)—estimated	2,400
Drainers	375
Fruit and pea pickers	34
Estimated number included in new classes	1,000
Others	1,474
Fishermen-crofters	1,236
Total	146,767
Or say	146,750

The numbers of male persons engaged in agricultural industries are thus given in Vol. III. of the Census Report (Table XII., page 318):—

Farming and stock-rearing	141,077
Poultry farming	369
Market gardening and fruit farming	2,861
Flower and seed growing and nursery gardening	2,544
Other agricultural industries	1,471
Total	148,322

We exclude "Other Gardening," "Forestry" and "Land and Estate Management," amounting in all to about 11,000, while about 9300 gardeners and gardeners' labourers engaged in domestic service are already excluded in the Census itself.

The measure of agreement between the two totals is not, however, so close as it appears to be, since the "agricultural industries" given above include about 3000 persons engaged in occupations that are not agricultural, while considerable numbers engaged in agricultural occupations (besides the specially large group of domestic gardeners) are placed in other industries. These can be traced in Table XIV. Thus, of the fishermen-crofters, 519 are placed in the Fishing Industry, and only 691 in the Farming Industry, while 169 persons engaged in agricultural occupations appear as Wholesale Dealers, 459 as Retail Dealers, and 1330 under "Other Industries and Industry Unspecified." We shall not be far wrong, however, if we state the number as 147,000 or 148,000. The decrease as compared with 1911 is thus about 10,000, or 6½ per cent. The first nine classes referred to above show remarkable changes, some of which are clearly due to alterations of description rather than of fact. Farmers and crofters have apparently increased by 2554, but the

decrease of 2643 in the number of fishermen-crofters brings out a net decrease of 89. Farmers' and crofters' sons and other relatives assisting in the work of farms or crofts show a combined decrease of 10,851, or 65 per cent.; grieves, shepherds and cattlemen, a combined decrease of 6182, or 20 per cent.; and horsemen and other farm servants a combined increase of 6022, or 10 per cent. "Grieves and Foremen" may be a somewhat ambiguous description, but shepherds are a quite definite class, and it is difficult to understand a decrease of 1593, or nearly 18 per cent., since the ewe stock of Scotland at its lowest point in 1920 was only 8 per cent. below the normal pre-war figure. The average number of ewes for each shepherd appears to have risen from 330 to 370. Cattlemen also present a difficulty, with a decrease of 18½ per cent.; the whole number of cattle in Scotland shows a decrease in 1921, as compared with 1911, of 5 per cent., and non-dairy cattle a decrease of 10 per cent. However that may be, there can be no doubt that the increases in the numbers of horsemen and other farm servants are to a large extent illusory. The area of arable land in Scotland (excluding the land under rotation grasses and clover) was greater in 1921 than in 1911 by 35,000 acres. As each man ploughs about 50 acres, this would require at most an increase of 700, leaving 1200 to be otherwise accounted for. This surplus, together with the 4100 additional "farm servants not distinguished," must be set off against the large decrease in the numbers of farmers' and crofters' sons, etc., mentioned above. Several thousand of these appear on this occasion to have described themselves as farm servants.

Censuses of 1911 and 1921—Females.

The following table gives the same particulars for women as are given above for men. Some of the items are very small, but they have an interest on that account:—

Class.	1911	1921	Increase + or Decrease −
Farmers	2,666	2,349	317
Crofters	4,046	2,550	1,496
Farmers' daughters or other relatives assisting	5,557	992	− 4,565
Crofters' daughters or other relatives assisting	5,117	1,439	3,678
Grieves or Foremen	29	10	19
Shepherds	11	16	+ 5
Farm Servants—			
In charge of Cattle	6,127	4,629	− 1,498
In charge of Horses	85	32	− 53
Not distinguished	8,785	10,221	− 1,436
Total of above Classes	32,423	22,238	− 10,185

CENSUSES OF 1911 AND 1921—FEMALES—*continued.*

Class.	1911	1921	Increase + or Decrease −
Brought forward .	32,423	22,238	− 10,185
Nurserymen, Seedsmen, Florists .	227	...	+ 1,073
Market Gardeners (including Labourers) .	185	...	
Other Gardeners (not Domestic) .	90	...	
Gardeners, Nurserymen, Seedsmen, Florists .	...	689	
Gardeners' Labourers .	...	886	
Fruit and Pea Pickers .	...	119	+ 119
Agricultural Machine, Tractor Proprietors, Managers, Foremen	6	2	− 4
Foresters, Woodmen .	15	64	+ 75
Labourers in Woods and Forests .		26	
Agricultural and Forestry Pupils .	..	68	+ 68
Land and Estate Agents and Managers .	...	6	+ 6
Estate Labourers .	...	54	+ 54
Other Agricultural Occupations .	111	165	+ 54
Total of above Classes	634	2,079	+ 1,445
Grand Total	33,057	24,317	− 8,740

Proceeding as before, we obtain the following figures for the total number engaged in agriculture in 1911 :—

Total of first nine classes	32,423
Market gardeners (including labourers) . .	185
Others	111
Fishermen-crofters	60
Total	32,779
Or say	32,750

The corresponding figures for 1921 are as follows :—

Total of first nine classes	22,238
Market gardeners (estimated)	200
Fruit and pea pickers	119
Estimated number included in new classes .	50
Others	165
Total	22,772
Or say	22,750

The numbers of female persons engaged in agricultural industries are thus given in Table XII. :—

Farming and stock-rearing	21,487
Poultry farming	143
Market gardening and fruit farming . .	1,053
Flower and seed growing and nursery gardening	700
Other agricultural industries	46
Total	23,429

This total includes about 1000 persons whose occupations are not agricultural, a larger proportional number than that of the men in the same position, while fully 800 women engaged in agricultural occupations are found (in Table XIV.) to have been placed in the industries of Wholesale and Retail Dealing, or under "Other Industries or Industries Unspecified."

We may conclude that 23,000 is fairly near the mark for 1921. The estimated decrease in the ten years is thus about 10,000, or 30 per cent. Absolutely, the decrease is about the same as the decrease in the number of men, while relatively it is four-and-a-half times as great.

Female farmers and crofters (including in 1911 "fishermen-crofters," who have disappeared in 1921), show a decrease of 1873. Thus the number of farmers, etc., of both sexes is fewer by 1962. Further reference will be made to this decrease. The apparent disappearance of farmers' and crofters' daughters and other relatives is even more startling than that of men and lads in the same status, the combined loss amounting to 8243, or 77 per cent. The remaining classes are practically unaltered in number, a large diminution in the number of women specifically returned as in charge of cattle being balanced by an increase in the "not distinguished" class. Evidently there has been a large decrease all round, which in the case of the last-named class is concealed, and more than counterbalanced, by a transference of women from the classes of farmers' and crofters' daughters, etc. There can be no doubt that the figures for these classes are greatly understated. We cannot believe that there are in Ayrshire only fifty-two farmers' daughters assisting in the work of farms, and in Lanark only sixty-three.

It is interesting to note that the tiny class of female shepherds has increased. The returns of women in charge of cattle are even more difficult to understand than the corresponding returns for men. There is an apparent decrease of 1498, or 24 per cent. (and if a certain number of farmers' daughters, etc., now appear in this class the actual decrease is even greater), while dairy cattle show a slight increase in the ten years. Possibly milking-machines have enabled the number of workers to be reduced.

If the Census figures for 1911 and 1921 are truly comparable, the broad fact is established that the number of women engaged in agriculture in Scotland was diminished by 30 per cent. in the ten

years. Attention has, however, been drawn, especially in the Report of the Committee on Women in Agriculture in Scotland (1920; pp. 6–7), to the great difficulty of obtaining accurate figures. Further comment will be made on this question in the next section of this article. Meanwhile we may summarise the Census figures as follows:—

	1911.	*1921.*	*Decrease.*
Males . . .	157,500	147,500	10,000
Females . .	32,750	23,000	9,750
Total . .	190,250	170,500	19,750

CENSUS AND AGRICULTURAL RETURNS—MALES.

Proceeding now to a comparison of the Census figures for 1921 with those obtained through the Annual Agricultural Returns, we observe that the latter exclude holdings of one acre or less; that the returns of labour include all workers except the occupier, his wife and domestic servants; and that separate figures are given for regular and for casual workers of each sex, as employed on 4th June 1921, the regular workers being divided between those over and those under twenty-one years of age. The schedules for the Agricultural Returns are filled up by the occupiers of holdings, while those for the Census are filled up by the householders concerned. In order to obtain comparable figures for male workers, we make the following adjustments:—

Total of first nine classes	140,248
Less farmers and crofters	46,520
	93,728
Market gardeners' labourers (estimated) . .	1,600
Drainers, etc., ...	400
Total	95,728
Or say	95,750

The placing of the other classes is doubtful, but they may perhaps be ignored.

The Annual Agricultural Returns give the following figures:—

Regular male workers	82,000
Casual " "	11,500
Total	93,500

If we may assume that all the casual workers were returned as agricultural workers in the Census, the discrepancy amounts to 2250, which is not very great in view of all the circumstances.

A few representative counties have been examined in order to establish a closer comparison. It should be noted that Table III.

of Vol. III. of the Census Report, which gives the distribution of each class by counties, includes retired persons, who are excluded from the figures given in Table II., and used hitherto in this article. A slight adjustment must therefore be made in using Table III.

The average percentage of retired persons among males in the whole group of agricultural occupations is 5·1, as compared with 3·5 per cent. for the total number of "occupied males." The other groups having high percentages of retired persons are "Professional Occupations" (5·7 per cent.), and "Public Administration and Defence" (5·4 per cent.). Retired farmers number over 4000, or 11·3 per cent. of all farmers, including the retired; farm servants average about 2½ per cent., but it is noteworthy that shepherds have the high percentage of 8·3.

The following are the figures for a few representative counties, calculated as for Scotland, and adjusted as stated above:—

	Census.	*Agricultural Returns.*
Aberdeen	13,000	12,600
Fife	4,800	4,750
Berwick	2,900	2,900
Ayr	5,300	4,850

The agreement is thus very close except in Ayr, where the discrepancy is about 8½ per cent.

CENSUS AND AGRICULTURAL RETURNS—FEMALES.

Very different is the result of a comparison of the returns of female workers. The Census figures, on the basis adopted for male workers, are:—

Total of first nine classes	22,238
Less farmers and crofters	4,899
	17,339
Market gardeners' labourers (estimated)	150
Fruit and pea pickers	119
Total	17,608
Or say	17,500

The Agricultural Returns give:—

Regular female workers	22,000
Casual " "	11,500
Total	33,500

Even assuming that none of the casual workers were returned as agricultural workers in the Census (the opposite assumption to that made in the case of the male workers) there is an excess of

4500 in the Agricultural Returns. Farmers' wives are specifically excluded from the Agricultural Returns, and while they are not specifically excluded from the Census heading "farmers' daughters and other relatives assisting in the work of the farm," it is doubtful whether a farmer's wife would describe herself as an "other relative" of her husband. Farmers' and crofters' wives may therefore be regarded as excluded from both returns, but if any of them are included in the Census the discrepancy becomes even greater.

An analysis of the county figures shows that large surpluses in the Agricultural Returns occur in the counties of Shetland, Orkney, Caithness, Sutherland, Inverness, Nairn, Moray, Banff, Aberdeen, Kincardine, Dumfries, Kirkcudbright, Bute and Argyll. Aberdeen shows the most abnormal figures, the Agricultural Returns giving 2000 regular workers, while the Census gives about 450. Ross is an exception to the general tendency in the crofting counties and the north-eastern area. A fair number of counties show agreement between the two returns, while Lanark furnishes an outstanding example of a surplus in the Census figures, which amount to about 2100 as compared with 1730 regular workers in the Agricultural Returns; there are also 1720 casual workers in these Returns, and no doubt in this county (as in others) some of them appear in the Census.

Our conclusion is that the question: "How many women are engaged in agricultural work in Scotland?" does not admit of a definite answer. "Engagement in agricultural work" is a matter of degree, and not a clearly defined concept that can be dealt with satisfactorily by statistics. The Annual Agricultural Returns, if the figures they give are reasonably accurate, tell us how many women were employed in agricultural work on a certain day, and a comparison of the figures for successive years shows the trend, while the Census figures, if actually comparable with one another, show the trend over longer intervals. But neither of them gives an absolute figure such as is fairly well established in the case of male workers. The marginal groups of members of occupiers' families and of casual seasonal workers are ill-defined, and farmers' wives are left out altogether, as well as domestic servants on farms, part of whose time may be spent in actual farm work.

BIRTH-PLACES.

Mention has already been made of the table giving the birthplaces of those engaged in each occupation (Table VIII.). As regards agriculture it is sufficient to say that out of the 169,984 male persons engaged in all "agricultural" occupations, those of Scottish birth numbered 163,280 or 96·1 per cent. as compared with 88·5 per cent. for all "occupied males"; 3040 or 1·9 per cent. were born in England and Wales; 3282 or 1·8 per cent. in Ireland; and 382 or 0·2 per cent. abroad. Of the 24,317 women so engaged, 23,061 or 94·8 per cent. were born in Scotland; 1·5 per cent. were born in England and Wales; 3·5 per cent. in Ireland; and 0·2 per cent. abroad.

MARRIED AND SINGLE.

The figures regarding "conjugal condition" are given in Table II. Those for male persons of the first nine classes so frequently mentioned already are as follows:—

Class.	Single.	Married.	Widowed.	Not Stated	Total.
Farmers	9,168	20,294	2,089	5	31,556
Crofters	3,844	9,576	1,544	...	14,964
Farmers' sons, &c. .	3,534	213	21	...	3,768
Crofters' sons, &c. .	2,166	116	6	...	2,288
Grieves, Foremen . .	882	4,090	258	...	5,230
Shepherds . . .	3,257	3,806	379	...	7,442
Farm Servants— . .					
In charge of Cattle .	6,597	4,335	311	...	11,243
In charge of Horses .	22,691	13,998	704	4	37,397
Not distinguished .	18,818	6,508	1,004	30	26,360
Total .	70,957	62,936	6,316	39	140,248
		69,252			

The whole body is almost equally divided between the single and the married and widowed. The latter class naturally predominates among farmers (71 per cent.), crofters (74 per cent.), and grieves (83 per cent.); shepherds show a smaller predominance of married men and widowers (56 per cent.); cattlemen about the same predominance of single men (58 per cent.); horsemen a larger proportion (61 per cent.); and those "not distinguished" a marked excess of single men (71 per cent.). Farmers' and crofters' sons, etc., are of course almost all single.

The corresponding figures for women are as follows:—

Class.	Single.	Married.	Widowed.	Not Stated.	Total.
Farmers	777	62	1,510	...	2,349
Crofters	988	112	1,456	...	2,550
Farmers' daughters, &c.	978	9	5	...	992
Crofters' daughters, &c.	1,403	23	13	...	1,439
Grieves, Foremen . .	6	2	2	...	10
Shepherds	16	...	...	...	16
Farm Servants— , .					
In charge of Cattle .	4,055	370	204	...	4,629
In charge of Horses .	27	3	2	...	32
Not distinguished .	8,526	950	731	14	10,221
Total .	16,776	1,531	3,917	14	22,238
		5,448			

Married women constitute only 7 per cent. of the whole, and widows 17·6 per cent. The latter naturally predominate among

farmers and crofters. The remaining classes show high proportions of single women.

AGES.

Table II. also gives an analysis by age. Out of the 169,984 male persons engaged in all "agricultural" occupations, 135 are boys of 12 to 14 years of age, 9248 of 14 to 16, and 11,528 of 16 to 18. At the other end there are 8614 men of 70 and over. including 2740 farmers, 2978 crofters and 1175 farm servants, Out of the 24,317 females in all "agricultural" occupations, 1276 are of 70 years and over, including 410 farmers, 721 crofters and 99 farm servants.

AGRICULTURAL OCCUPIERS.

The numbers of agricultural occupiers included in the Census returns in 1911 and 1921 are as follows:—

	1911.	*1921.*
Farmers—Male	29,939	31,556
„ —Female	2,666	2,349
Crofters—Male	14,027	14,964
„ —Female	4,046	2,550
Fishermen-Crofters—Male	3,879	1,236
„ „ —Female	60	...
Market Gardeners, etc. (estimated)	1,000	1,000
Total	55,617	53,655

This shows a decrease of nearly 2000, closely agreeing with the decrease in the number of holdings recorded in the Annual Agricultural Returns, from 77,950 to 76,000. It will, however, be observed that in each year the number of holdings exceeds the Census number of occupiers by over 22,000. The difference is to be accounted for to some extent by cases where one person occupies several holdings, but mainly by cases where the occupier is not principally engaged in agricultural work.

Probably, however, the number of agricultural occupiers entered as such in the Census is unduly small, and a certain additional number of occupiers is sufficiently engaged in agricultural work to justify inclusion in a final estimate of the total number of persons so engaged. In Part I. of the Agricultural Statistics of England and Wales for 1921 (page 15) it is suggested that to the number of employees there should be added 400,000 occupiers, while in Part I. of the Statistics of Scotland for the same year (page 15) the addition of 70,000 occupiers is suggested. These figures, exceeding 90 per cent. of the whole number of holdings in each case, are no doubt too high. On the other hand the Scottish Census figures quoted above give only about 70 per cent. If we take 80 per cent. as a fair figure, the number of occupiers to be included will be about 60,000, and distributing the

additional 6500 or thereby roughly between men and women, we obtain the following adjusted figures for the total numbers engaged in agricultural work in 1911 and 1921 respectively:—

	1911.	*1921.*	*Decrease.*
Males	162,000	152,000	10,000
Females	35,000	25,000	10,000
Total	197,000	177,000	20,000

TOTAL AGRICULTURAL POPULATION.

Materials are also available in the Census Report for an estimate of the total agricultural population of Scotland in 1921, *i.e.*, the number of persons included in families dependent on the industry. A statement has been given above of the numbers of single, married and widowed male persons engaged in the principal agricultural occupations. Applying the same proportions to the estimated total number of male persons engaged in agriculture, we get the following distribution:—Single, 77,000; married, 68,000; widowed, 7000; total, 152,000. To this we add 68,000 wives of married men and 25,000 women and girls as occupiers of holdings or workers.

Volume IV. of the Report gives the number of dependent children for each married man and widower in each occupation. The averages for agriculture are 1·62 and 0·47 respectively. Of the principal classes, married horsemen show 2·23; cattlemen, 2·19; grieves, 2·10; shepherds, 1·76; farm servants "not distinguished," 1·60; farmers, 1·47; and crofters, 1·29. The average figures give a total of 114,000 children. There are, however, some doubtful items. Dependent children go up to sixteen, and apparently boys and girls under that age actually working in agricultural or other occupations are included. Some of these would thus be reckoned twice. The number of boys under sixteen working in "agricultural" occupations in 1921 was 9485 and girls 1927, almost all of whom were engaged in agriculture in the strict sense. It is, however, impossible to say how many of these were the children of agricultural workers. If the whole 11,000 or thereby were in this position, our total would have to be reduced to 103,000. But perhaps a reduction of 7000 will be fairly near the mark.

On the other hand there is no information as to the number of children dependent on the 1700 married women and the 4000 widows engaged in agricultural work. The children of the former were no doubt reckoned as dependent on their fathers, who might or might not be counted already as agricultural workers. Of the 4000 widows, 1500 were farmers, 1450 crofters and 950 farm servants. These widows would have, on the same ratio as widowers, 2000 dependent children. The total number of children may therefore be estimated at 114,000 − 7000 + 2000 = 109,000.

No attempt need be made to discriminate, among the 1700 married women engaged in agricultural work, between those who have also been reckoned as wives of men so engaged, and those who have not been so reckoned. The number is so small that any discrimination would not seriously affect the grand total, which can be regarded as accurate only within comparatively wide limits.

The final estimate is as follows:—

Working	Married men	68,000
	Widowers	7,000
	Single men and lads	77,000
	Women and girls	25,000
Others	Wives of married men	68,000
	Dependent children	109,000
	Total	354,000

This total is exactly double the number of workers. The ratio would probably have been put higher by most persons, in the absence of the official information that is now for the first time available.

STATUS OF AGRICULTURE AS AN INDUSTRY.

Lastly, a word may be said as to the relative status of agriculture among Scottish industries.

In the Table of "occupations—males" the group of "agricultural occupations" (including forestry and gardening of all kinds) comes second with 169,984, or 11 per cent. of the whole. "Metal workers" are first with 280,210, and the "transport and communication" group runs agriculture close with 167,912. Among women, the agricultural group takes the seventh place, with 24,317, or nearly 4 per cent. of the whole. Combining the sexes, we find "metal workers" still a long way in front with 286,747. "Personal service" and "commercial, finance and insurance occupations" have each about 200,000, and "agricultural occupations" take the fourth place with 194,301, or 8·9 per cent. of the 2,179,269 "occupied persons" in Scotland.

Under the grouping by "industries—males," "agriculture" comes fourth with 159,305, or 10·5 per cent. of the whole. "Manufacture of metals, machines, etc.," shows the huge number of 349,109, "mining and quarrying, etc." has 175,000, and "commerce and finance" 168,219. Among the industrial groups of female workers agriculture takes the eighth place with 23,781. Combining the sexes as before, we find that agriculture takes the fourth place with 183,086. "Manufacture of metals, machines, etc.," has 368,610, "commerce and finance" 289,369, and "personal service" 199,648. These four industries include nearly half the workers of Scotland.

Edinburgh College Experimental Farm.

THE work of the Edinburgh and East of Scotland College of Agriculture has always been handicapped by the want of a properly equipped experimental farm. The acquisition of a suitable farm was a problem of much difficulty, and it was not due to any lack of interest or enquiry on the part of the governors that so many years elapsed before a suitable farm was obtained. In the first place, the farm had to be sufficiently near Edinburgh to be easy of access and yet sufficiently far out not to have any feuing value. In the second place, while different types of soil on the farm were desired, yet it was necessary that the individual fields should be as nearly uniform as possible. The possession of some hill land was also considered desirable. There was the further consideration that the farm should be acquired as near the end of a lease as possible to obviate the payment of a large sum in compensation. It will be admitted at once that to get a farm possessing all these conditions, and at such a price and of such a size as the College could afford to buy, was by no means an easy matter.

It is true that the College were tenants for a short time (1913-1917) of the farm of Dreghorn, but the terms on which the farm was held were uncertain, and while a limited amount of experimental work was carried out there, it was impossible to lay down any experiments of a permanent character. The rapid expansion of the barracks at Redford and the utilisation of the land for military purposes forced the College to give up the farm in 1917.

In 1922, however, the governors were able to acquire by purchase the farm of Boghall, which formed part of the Pentland Estate of Major Gibsone. The farm is situated on the Carlops Road, and is about five miles from the College, while it is distant about two miles from the Braid Hills car terminus; access can also be had directly to the farm at Seafield by the motor bus service to Penicuik *via* Lothianburn.

The farm extends to a little over 600 acres, of which about 230 are arable, and the remainder hill land. The arable land lies mostly between the road to Carlops and the road to Penicuik.

The Board of Agriculture for Scotland contributed half the cost of the purchase price of the farm, and in addition are providing certain sums towards its stocking and equipment. A quarter of the purchase price was provided by the Scottish Education Department, while the remainder was found by the Colleges out of a fund collected before the war for the provision of a farm, and contributed to by private subscribers and various public bodies.

The College acquired possession of the farm at Martinmas 1923—Mr J. C. F. M'Intyre, B.Sc., a former student of the College, being appointed farm manager.

The equipping of the farm for experimental purposes requires not only a considerable financial outlay, but also very careful planning, and several years must elapse before the farm can be

properly developed as an experimental station. In the first place, a careful survey of the farm had to be made to determine which parts were suitable for experimental purposes, and secondly, the experimental work had to be allotted to the most suitable ground in each case—work which required a very considerable amount of care. A start, however, has been made, and a certain amount of experimental work has already been laid down this season, which it is hoped will be considerably increased next year.

A field of about 12 acres (Cow Loan) has been set aside permanently for variety yield trials, and is being brought under a six course rotation, namely—oats, potatoes, wheat, swedes, barley, hay. Before the plots were laid down the soil was carefully sampled all over the field, and chemical and mechanical analyses carried out. These analyses showed that the greater part of the field was very uniform, and that certain smaller portions differed somewhat in composition; where the variation is material, the ground is excluded from the trials. The individual plots are small—about $\frac{1}{80}$ of an acre in extent, and each variety is repeated in four separate plots. To be able to estimate the effect of any slight variation in the soil of the field the plan has been adopted of introducing alternate check plots of a standard variety throughout the whole series. Thus in the case of oats all the odd numbered plots from 1 to 65 are under Svalöf Victory Oat, and the intervening plots are arranged as follows:—

Svalöf King	Plots	2, 18, 34 and 50
Abundance	,,	4, 20, 36 ,, 52
Svalöf Crown	,,	6, 22, 38 ,, 54
Record	,,	8, 24, 40 ,, 55
Superb	,,	10, 26, 42 ,, 58
Castleton Potato	,,	12, 28, 44 ,, 60
Leader	,,	14, 32, 48 ,, 64

Varieties of barley, potatoes and swedes are being tested on the same lines. The produce from each individual plot will be separately weighed and the results tabulated.

With regard to the experiments laid down this year, a curious phenomenon has occurred in the case of the variety "King." The seed was obtained direct from Sweden and germinated 99 per cent. Notwithstanding this, the variety came up very thin and a count of the seedlings established the fact that little more than one-third of the seed had produced plants. The seed was retested on soil and germinated 98 per cent. Similar complaints as to the failure of this oat have been received from certain of the County Work Organisers who have also sown it out in their experimental plots. The reason for the discrepancy between the germination and the field results is not yet clear, but the matter is under further investigation.

The difficulty that always arises when seed of different varieties is collected from different sources is being obviated as far as the future is concerned by growing quantities of the various varieties on the farm itself.

A second field (Crofts) has been set aside for experiments in methods of cultivation, seeding, etc., and is this year laid down under Victory Oats, sown at different rates and by different methods. Two plots have been put in at the ordinary standard rate of six bushels, sown with the ordinary disc drill. Three plots are "surface sown" with a special drill at the rates of 3, 4 and 5 bushels respectively, one of the claims made for this method of sowing being that a considerable saving of seed can be effected. One plot is sown according to a scheme that is becoming common in certain districts; the rate of seeding is 6 bushels, but half is broadcasted on the ridges and harrowed in, the remainder being drilled across the ridges. In order to furnish a further check on the thin seeding with the surface drill a further plot has been added, sown at the rate of 3 bushels with the ordinary disc machine.

A part of this field is laid out in experiments on the cultivation of lucerne.

In this field, also, it is proposed to have a Meteorological Station, and to have lysimeters or drain gauges for the study of drainage. The Meteorological Station will be fully equipped with the most modern type of instruments and will be under the general supervision of the Air Ministry. In conjunction with the Air Ministry and the Board of Agriculture for Scotland a scheme for collecting data on the times of brairding, ripening, etc., of the different farm crops will be carried out, with the view of getting more definite information on the effect of the weather on the general rate of growth, ripening and yield of the crops.

The provision of lysimeters or drain gauges will be an important part of the equipment of the station. The drainage water from plots under different manurial treatment will be collected and analysed, and information obtained as to how the manure applied is distributed between the crop, the soil and the drainage water. For many years the only lysimeters in this country were those at Rothamsted ; more recently a second set was constructed at the North of Scotland College Experimental Farm at Craibstone. As was to be expected, the results at Aberdeen, owing to the very different type of soil involved, differed widely from those obtained at Rothamsted. Much additional information is necessary on this important question of the retention of manurial substances in the soil, as it affects the whole question of the valuation of manurial residues left by feeding stuffs consumed and by manures applied during the last years of a tenancy. The results from the gauges at Boghall should provide important additional data.

A small portion of a field where the soil is very acid is being retained for experimental purposes. Experiments are being carried out to determine the causes of failure of certain crops on acid types of soil and to determine the resistance of crops and of different varieties of the same crop to acid soils.

A trial of varieties of red clover is being laid down at present, the grass seeds being sown under rape. Three series of plots

have been laid down on different parts of the hill with various phosphatic manures alone and in combination with potash and lime. Results from these are not, of course, expected until the lapse of a year or two.

The hill land carries a stock of fourteen score blackface ewes, and steps are being taken to establish a regular breeding stock.

The following account of the vegetation of the glen and hill is contributed by Dr Smith :—The hill and glen, about 350 acres, though limited in area, includes a useful selection of kinds of herbage and of grasses typical of hill pastures in general. There is, however, little peat, nor is the heather extensive, being confined to near the summits of Caerketton and Allermuir. A large part of the hill is on a porous soil on stoney slopes, well suited for gorse (whin), but carrying a thinnish grassy herbage. In places bracken is common, and experiments have been laid down to examine best times for cutting and other means of control. During the past year attention has been given mainly to improvement of the lower land adjoining the Boghall Burn. Much of this shows signs of former cultivation, but it is long ago, and there is no record. Some parts of the ridged land have been constantly grazed, and bear a short grassy herbage of a poor kind, and with little white clover. Other parts, formerly cultivated, have been invaded by white-grass or moor mat-grass (*Nardus*), an inferior grass found on all hill pastures. The area of this grass is so large at Boghall, and its grazing value is so small, that its control is the main problem for the present. There is evidence that it has spread over better herbage, and is still spreading, so that the pasturage becomes rougher every year. This year, in March, almost all the white grass was burned over, leaving only a few central parts for comparison, and already now (May) the hill is covered with fresh green grass, grazed by the sheep, though probably in a few weeks the white grass will be left ungrazed.

Centres for manuring have been laid down in three parts of the glen and plots, varying from one-tenth to one-half an acre, and have been top-dressed with basic slag and mineral rock phosphates of various kinds, with additions of ground limestone (1 to 4 tons) and Kainit (4 to 6 cwts.) in places. Over 5 acres have been treated with 3½ tons of phosphatic and other manures.

The grassy herbage is extremely variable, much more so than grass land in enclosed fields, and methods are being devised to obtain accurate records of changes due to manuring, etc. One survey shows the state of grazing before the application of the manures, and it is exact enough to allow of locating any square yard of the 5 acres under experiment, so as to compare the state of grazing a year or more hence. Other records give the distribution of white clover and other plants before treatment, and are available for future reference. There are already indications that some mixtures of grasses are more completely grazed, while others are left, also that the response to manuring varies according to the kind of herbage.

The glen, on account of its small size, allows of frequent examination of the various experimental centres, and being attached to the College and under its control, there is a greater opportunity for detailed investigations than on hill pastures elsewhere.

The College provides accommodation for the breeding-stock of sheep belonging to the Joint Committee on Research in Animal Breeding.

Another experiment which will be a source of considerable interest is being carried out by the Board of Agriculture for Scotland. The Board has leased about 10 acres from the College for carrying out a Scottish Egg-Laying Competition. This experiment, which will probably arouse much interest amongst poultry farmers, will be commenced in the autumn of the present year.

The plans for the alteration of the farm buildings, so as to adapt them for the purposes of cattle-feeding experiments, are now under the consideration of the Governors, and it is hoped that the alterations will be put in hand at an early date. It is also proposed to erect an Implement Demonstration Shed where the most recent types of agricultural implements and machinery will be obtained on loan for demonstration purposes. Students will be instructed in the structure and adjustment of these implements, and it is felt that this should be a useful addition to their College course.

The farm is already being used by Professor Watson in connection with class-work in agriculture, and by Dr Smith in the teaching of agricultural botany, and, as the station is developed, its usefulness for teaching purposes will be greatly increased.

AGRICULTURE: THE SCIENCE AND PRACTICE OF BRITISH FARMING. *J. A. S. Watson, M.C., B.Sc., and James A. More, B.Sc., N.D.A., N.D.D. Oliver & Boyd, Edinburgh and London, 1924. Price, 15s.*

Reviews.

The authors of this volume have to be congratulated heartily on the very successful manner in which they have dealt with this large and very difficult subject. This treatise differs essentially from the majority of text-books on agriculture in that it is not a mere statement of rules or details of practice, but that it presents broadly the main facts and scientific principles underlying the practice of agriculture and will therefore make a wider appeal to students than if the information were applicable only to certain localities and restricted conditions.

In the first part the main factors on which the fertility of the soil depends are dealt with concisely, and, following this, the general principles to be followed in the improvement of soils by tillage, manuring, etc., are very ably expounded. All the latest types of agricultural implements and machines are fully described and very valuable information given as to the selection of these for different farming conditions.

The second part is devoted to the crops of the farm, each crop being dealt with separately as regards its soil requirements, manuring, seeding, etc. The standard varieties in each case are also fully described, and details given as to the selection and improvement of seed. The question of soiling crops and ensilage is also fully gone into, the different types of silos being described in detail and their relative advantages considered. Valuable suggestions are also made regarding the threshing of the cereal grains, and the storing and disposal of farm crops generally.

A clear description is given of the main insect and fungoid pests that attack the different crops, and the means whereby the ravages of these pests may be either prevented or mitigated.

Special attention is paid in this section to the seeding of pastures, the fundamental principles of making up grass seed mixtures being lucidly enunciated and clearly illustrated by reference to mixtures suitable for different soils and types of grass land. The general management and the stocking of the pastures are also very clearly dealt with.

The third part of the volume, which incidentally the reviewer likes best, deals very fully with all questions relating to live stock.

In the opening chapter of this section a very complete survey is made of the more recent phases of the study of heredity and their bearings on all problems connected with the breeding of farm animals. The methods to be adopted for the improvement of farm stock are also fully discussed, reference being made to the work of noted breeders of the past as well as to recent research work in connection with this subject. The principles of animal nutrition and the general principles of the management of all classes of live stock are also fully dealt with. In dealing with the different breeds the authors make a very sensible departure from the usual method of treatment followed in publications dealing with this subject. They first of all deal with different types and then pass on to consider the breed characteristics and the relative economic values of the individual breeds, a subject which they deal with in a very impartial way. This arrangement of the subject has several advantages; in the first place it avoids the monotonous repetition of many points which are common to all the breeds within a given type; it encourages the student to a study of the correlation of form and function in connection with live stock, and it makes the study of the individual breeds much simpler and more interesting.

The last section of the volume deals with farm organisation and management under the three heads—"Land and its Equipment," "The Choice of the Departments of the Farm," and "Systems of Farming." Here the selection of the crops, the system of cropping, the stocking, the capital required for equipment, running expenses and labour, are all very fully entered into, and illustrations of systems of farming on selected farms in different districts of the country are given in detail. We do not recollect having seen these subjects so adequately dealt with before, and they form an important and valuable part of the work.

In the appendices are given several tables dealing with

manures, feeding stuffs and standard rations for stock, and these complete a work that is a welcome addition to our agricultural literature.

If throughout the work the writers sometimes seem to challenge generally accepted views, yet on closer reading it will be found that they invariably adduce sound reasons for doing so, and this we consider is no small merit in a publication which has for its object the encouraging of the student to think for himself rather than to accept the ready-made opinions and statements of others.

Although designed primarily for students of Agricultural Colleges and Farm Institutes, this volume will be found to be a mine of accurate and authoritative information for all who are interested either in the theoretical or in the purely business and practical sides of the industry.

It is clearly printed on excellent paper and is profusely illustrated throughout with reproductions of photographs and sketches which have been carefully selected with a view to their relation to the text, which they enhance considerably in both value and interest.

The Agrarian Revolution in Roumania.

By Ifor L. Evans, Fellow of St. John's College, Cambridge.

Cambridge, at the University Press, 1924.

THIS is a very thorough study of the subject, so far as is possible, when so little time has elapsed from the great redistribution of land recently carried through in the country, that only its immediate effects can be judged. The historical setting of the movement is carefully described. The task is a little complicated by the fact that greater Roumania is almost twice as large as the two Danubian provinces, Moldavia and Wallachia, which formed the Roumania of the nineteenth century, and Mr Evans has not shrunk from giving an account of recent agrarian conditions in the recently annexed—or should we say recovered?—provinces of Bessarabia, Bucovina and Transylvania. Roumania, indeed, resembles Poland in that different parts of its recovered "irredenta" regions were within the former Russian and Austro-Hungarian Empires. Hence Bessarabia, which was a Russian province, had its agrarian settlement at the same time as the rest of the Russian Empire. It is true that Southern Bessarabia was awarded to Roumania in 1855 as part of the settlement made at the end of the Crimean war; but Russia wrenched it back from Roumania in 1878, the most cynical and outrageous treatment to mete out to a brave and loyal ally in the very war, the issue of which made this possible, that can be conceived. So the whole of Bessarabia was Russian from 1878 to 1918, and shared in the agrarian movement of Russian lands during that time. The transfer of land from the noble to the peasant was going on during this time more rapidly in Bessarabia than in most Russian provinces, as the Bessarabian "boyars" or nobles were more feckless, and the

peasants more prolific and diligent than the respective classes in most parts of Russia.

Mr Evans makes the emancipation law of Prince Alexander Cuza in 1864 the starting point of modern agrarian law in Roumania. Thirty years before this the trade in cereals, formerly monopolised by Turkey, had become free; thereupon, and in consequence of the development of communications, land had acquired an economic rent, and the transition from pasture to arable had been rapid. The boyars, or nobles, were anxious to seek the advantage out of these changes, and intent on keeping the peasantry out of the possession of land in order to secure their labour for the cultivation of the large estates. In 1864 the majority of the peasants were still in a state of serfage. The "boyars" wished emancipation to be granted without the allocation of land to the peasantry. Prince Cuza over-ruled them, however, and passed a law under which nearly half a million peasant families were emancipated, and placed in possession of over four million acres of land. The law, however, was faulty, and its application imperfect. Hence there was but little agrarian peace in Roumania for the rest of the nineteenth century. Mr Evans hardly emphasises the economic dependence of the peasantry on the boyars as strongly as has been done recently by a Roumanian writer, Mr G. Ionescu-Sisesti, who affirms that the law of agricultural contracts passed in 1866 tended to re-establish something like virtual serfdom. Towards the end of the century, however, laws were passed to make the peasantry independent of the nobles by making more land available to them.

Mr Evan's account of the circumstances under which the recent agrarian reform was conceded and carried out is clear and interesting. Under the stress of the defeat of Roumania by Germany, the King and the Government saw and the nobles acquiesced in the view that in order to carry the country through the hour of humiliation, and save it from a desperate revolution such as happened in Russia, the demands of the peasants, who formed the bulk of the Roumanian armies, for land must be met liberally and sincerely. It was much the same recognition of a necessity that had come to Stein and his colleagues after Jena. Hence even in June, 1917, during the German occupation of Bucharest a constituent assembly met at Jassy to affirm the principles of expropriation for reasons of national utility. Shortly after the province of Bessarabia, which had seceded from the Ukraine, through its Provincial Assembly passed a severe law of expropriation before throwing in its lot with Roumania; and the Roumanians of Transylvania, the Banat, and Bucovina made agrarian reform part of the programme upon the acceptance of which depended their entry into the Roumanian kingdom.

The Jassy amendment provided for all public land and an area of two million hectares to come from the estates of private owners to be made available for division among the peasants. This was not enough, and a further law was passed in 1921. Under the

laws two-and-a-half million hectares had already been expropriated at the time when Mr Evans was writing his book, and a further area was in course of a similar process, which would bring the total area so dealt with in old Roumania up to seven million hectares. In Bessarabia nearly two million hectares have been expropriated; the whole process was over by the summer of 1923, and there are no large estates left. In Transylvania and Bucovina the operation is proceeding more slowly, as the demand is less insistent.

Mr Evans deals with the probable effect upon production of this great and rapid change in land tenure over a fairly large territory. On the whole he is inclined to defend the new order against the criticisms likely to be made against it. In any event the agricultural community would have been hampered by the wholesale commandeering of live stock which the Germans made during their occupation. Again, the export of cereals has apparently been partly diminished by the necessity of sending part of the crop to Transylvania, where production has diminished since the war, though the distribution of land there has been slower than elsewhere.

On the whole Mr Evans puts his case moderately, and he might have made more of it. Roumanian writers emphasise the defects of the old régime. One writer, himself a Roumanian landowner, who had studied agricultural economics in Germany, wrote a study some years ago, pointing out the relatively primitive standard of farming on the Roumanian plains, and the inadequate outlay of capital on farm buildings and other equipment. Similarly another writer, who has already been quoted, calls attention to the fact that the Roumanian landowners depended very largely for the cultivation of their lands on métayage, and that accordingly under the old régime it was very largely peasant farming. It is true that the Roumanian Government has regulated the export of wheat from the country; but if one thing is clearer than another it is that under the old régime the surplus was created largely at the expense of the half-starved Roumanian peasant.

The Correlation of Meteorological and Crop Data.

THE broader aspects of the effects of weather on the growth of crops have been observed ever since agriculture began, but hitherto in Great Britain little progress has been made in the more precise system of observation of plant growth, etc., in relation to meteorological conditions, which has been developed in certain other countries, notably in the United States. For some years the Board of Agriculture for Scotland have obtained particulars from their crop reporters and other persons of the dates of the critical stages of the growth of field crops and fruit trees and bushes, which have been transmitted to the Meteorological Office with a view to establishing a correlation

between these data and the meteorological conditions of the season. Now, however, a much more comprehensive and thorough scheme has been inaugurated by the Meteorological Committee of the Agricultural Research Council, on which the Board are represented along with the Ministry of Agriculture and Fisheries and other appropriate bodies.

The observation stations are to be situated at the experimental farms belonging to agricultural colleges, where the close observation of plant growth forms an essential part of the normal work of the staff, and where meteorological observations of a relatively simple type would naturally be made in connection with this work. The observations that are required to be taken at all stations are—humidity (three times a day), air temperature (except maximum in sun), soil temperature at 4 and 8 inch depths, wind, rainfall and sunshine. Further observations that it is hoped will be taken are—air temperature (maximum in sun), solar radiation, cloud, weather, barometer and attached thermometer, soil temperature at 2 feet depth. The full range of observations involves the provision of a considerable number of instruments, and entails a period of training for the observer.

The agricultural observations are to be taken on the same fields each year, and should relate to the same varieties of crops each year. The following are the field crops to be kept under observation—wheat, barley, oats, turnips, swedes and meadow hay. The observations to be noted on cereal crops are given as a sample—variety, soil, characteristics, previous cropping, manuring, cultural operations, dates of sowing, appearance above ground, breaking into ear, flowering, and harvest, yield per acre of grain and straw, bushel weight; attacks of diseases and pests. The agricultural crop observer is also expected to keep a full crop weather diary.

About a dozen stations are being established in England and Wales, and in Scotland arrangements are being made for stations at Boghall Farm, under the Edinburgh and East of Scotland College of Agriculture, and at Craibstone Farm, under the North of Scotland College. The Board and the Colleges are working in close conjunction with the superintendent of the Meteorological Office, Edinburgh, in carrying out the arrangements. It is expected that the work will begin on 1st September. The full scheme embraces horticultural observations and phenological observations of a large range of trees and perennial wild plants, but for the present the observations at the Scottish stations will be limited to field crops.

No immediate results can be expected from a piece of research of this character, but it is hoped that in the course of years it will lead to more exact knowledge of the effects of heat, moisture and other conditions on the growth of crops and of the relation between these meteorological conditions and the incidence of diseases and of attacks by insect pests.

Conference of Agricultural Research Workers in Scotland.

THE second annual conference of those engaged in agricultural research in Scotland is being held on 24th and 25th July at Glasgow and Kilmarnock, under the presidency of Sir Robert Greig, chairman of the Board. The object of these conferences is to bring together all who are engaged in agricultural research in the country, so that matters of common interest may be discussed, and co-operation and co-ordination of effort be arranged wherever possible and desirable. Opportunity is also taken to have present representatives of the county staffs as well as of the central staffs of the agricultural colleges, in order that they may be kept in touch with the investigations which are being conducted.

The first days' proceedings take place in the West of Scotland Agricultural College Buildings in Blythswood Square, Glasgow, where papers will be read, to be followed by discussions, and where also demonstrations in animal diseases and other research work will be given. On the second day the meetings take place at Kilmarnock, where the Experimental Farm, the National Dairy School, the Dairy Research Station, the Horticultural Experimental Station and the Apiary will be visited, and demonstrations will be given by members of staffs.

National Dairy Council for Scotland.

AT a largely attended and representative meeting held on 27th May in the City Chambers, Glasgow, and presided over by Lord Provost Montgomery, a resolution was adopted that a National Dairy Council for Scotland be formed with the objects of (*a*) improving the supply of milk and its products, (*b*) increasing the demand for milk, and (*c*) educating the public in the advantages of milk in the national diet. The movement for the promotion of this Council was set on foot by the Board of Agriculture for Scotland, partly as a result of reports made to them by delegates from this country who attended the International Dairy Congress last year in Philadelphia. There the work of the Dairy Council has met with great success, and the Board's hope is that similar results may be achieved in Scotland.

The proposal was advocated in speeches made by the Lord Provost; Sir R. Greig; Dr. Orr, Aberdeen; Professor Cathcart, Glasgow; Mr Buchanan, Paisley; Mr T. Dykes, Glasgow; Dr Simpson, Edinburgh; Mr Batchelor, Dundee; Mr James Dunlop, and others; and the motion to constitute the Council was moved by Bailie Allan, Glasgow, seconded by Captain Elliot, M.P., and carried unanimously.

A committee was appointed to suggest a constitution for the Council and the method of representation of the different interests.

Scottish Cattle Breeding Conference.

IN 1900 the unique researches of the Austrian monk, Gregor Mendel, came into prominence, and initiated an era of experimental breeding. Mendel's great contribution to science was his discovery that heredity was conditioned by a set of unit factors which were transmitted from parent to offspring, and that these unit factors were comparatively stable. In the last twenty-four years a vast amount of research along Mendelian lines has been carried out, and a very great deal of information of great practical value to the livestock world has emerged from these researches.

The Scottish Cattle Breeding Conference was convened chiefly for the purpose of reviewing the recent advances in our knowledge of breeding; to make a comparative study of breeding systems, breeding theories and practice; and to consider the practical problems of the breeder in the light of our recently acquired knowledge. Another phase of the Conference activities has been to survey cattle breeding in all the chief cattle countries of the world. The keynote of the meetings was the application of the new science of genetics to practical breeding, and every endeavour has been made to initiate a closer association of science and practice in the livestock breeding of Great Britain.

Papers were presented by practically all the great breed improvers of to-day. They came from all parts of the English-speaking world for this purpose, and the gathering together of such an eminent group of authorities is certain to be productive of a great deal of benefit to the breeders of this country.

The book on cattle breeding which will be issued shortly will be chiefly a survey of the subjects dealt with at the Conference. It is to be issued at the price of 12s. 6d. per copy, and this low price is possible only because the services of all the authors were given gratis, and there is to be no financial profit out of the Conference. In addition, all the office-bearers acted in a purely honorary capacity, and the Conference received the practical support of breed societies. It is expected that the book will be an authoritative guide for practical breeders and students of genetics for a long time to come. At present there is no satisfactory book which deals with this branch of breeding.

Some of the chief subjects discussed were as follows:—Our present knowledge of heredity in cattle was dealt with by a number of different workers, including Dr. L. J. Cole, Chief of the Animal Husbandry Division of the U.S.A. Bureau of Animal Industry; Lieut.-Col. E. N. Wentworth, Director of Armour's Livestock Bureau, Chicago; Professor J. Scott Watson, University of Edinburgh; Dr. Raymond Pearl of the Department of Biometry and Vital Statistics at the Johns Hopkins University, Baltimore, and others. Sex in cattle was dealt with by Dr. F. A. E. Crew, Director of the Animal Breeding Research Department, Edinburgh. Problems in breeding, such as selection, breed improvement methods, etc., were dealt with by Dr. G. F. Finlay of the above Department, Professor Scott Watson, and others. Problems connected with dairy cattle breeding were very fully gone into, Mr. J. Mackintosh of the National Institute for the Research in Dairying, Reading,

and Mr. H. G. Saunders of Cambridge, taking a prominent part. Physiology of reproduction in its more practical application to breeders was in the hands of Mr. J. Hammond of Cambridge.

There were a number of more educational subjects dealt with, as, for instance, "Origin of Cattle," by Professor J. Cossar Ewart, and "History of Stock-Breeding and the Formation of Breeds," by Professor James Wilson of Dublin, while there was a symposium of the ever interesting subject of Hybridization of Cattle by a number of experimenters from various parts of the world. An interesting subject dealt with by Lieut.-Col. Wentworth was entitled "The Effects of Fairs and Markets in Determining Cattle Type."

Agricultural Workers' Wages (Europe).

THE following report of a question and answer in the House of Commons regarding agricultural workers' wages throughout Europe is taken from *Hansard* of 6th June 1924:—

Mr Briscoe asked the Minister of Agriculture whether he has any information showing which are the countries in Europe where wages of agricultural workers are regulated; and will he state whether it is by the State, and what the regulated wages are?

The Minister of Agriculture (Mr Buxton): In a number of countries in Europe the wages of agricultural workers are regulated under some system of State control. In Hungary and Esthonia the machinery appears to resemble the Trade Board system in existence in this country. I am circulating in the official report such information with regard to the various countries as is in my possession. I have no definite information as to the current rates of wages.

Following is the information:—

The following is a summary of such information with regard to the regulation of agricultural wages in Europe as is in the possession of my department:—

The particulars have been collected from various sources, and must not be taken as necessarily complete.

Austria.—In the absence of collective or individual wage contracts, wages must not be less than permanent statutory minima fixed by law.

Belgium.—Individual bargaining is the general rule, with provision for appeal to boards of arbitrators. In certain provinces the decisions of the arbitration boards have force of law.

Czechoslovakia.—Collective agreements (which must be registered with the State Labour Department) must be based on a scheme of labour conditions and scale of wages drawn up annually by the Agricultural Department of the Ministry of Labour. Disputes are referred to joint committees, and, if necessary, to arbitration courts.

Denmark.—Wages boards consisting of three conciliators are charged with the duty of administering agreements reached between employers' and workers' organisations. In the event of a dispute

the matter is referred to the Permanent Arbitration Court, whose findings have the force of law.

Esthonia.—Provisional joint committees meet every year for the purpose of considering minimum rates of wages and the hours of work, their proposals being submitted to the Ministry of Labour, which communicates them to the National Joint Committee. The National Committee examines and co-ordinates the proposals of the provisional committees, which are then, if approved by the Ministry of Labour, published, and assume the force of law.

France.—As in Belgium, individual bargaining prevails throughout the country. Conciliation committees act in cases of dispute.

Germany.—Conciliation boards exist to solve difficulties arising out of collective agreements.

Hungary.—Under an Act passed last year, a system is to be established for the fixing of agricultural wages by district committees (comprising representatives of both sides, and an independent president and vice-president). The rates fixed will be enforceable by law. Pending organisation of the new system, the Act empowers the Minister of Agriculture to fix a minimum rate for 1923 and 1924.

Italy.—Conciliation committees are believed to exist for the settlement of disputes.

Netherlands.—Provision is made for conciliation in cases of disputes affecting fifty or more workers.

Norway—Settlement of disputes rests with industrial courts.

Poland.—Disputes arising out of collective agreements are dealt with by joint conciliation and arbitration committees. As a temporary measure, a special arbitration Board was set up in 1921 with power to fix wages and working conditions of agricultural labour, and this Board has continued to function up to the present.

Sweden.—Machinery has been established for arranging of collective agreements. Any disputes are referred to a central arbitration court, whose decisions are enforceable by the organisations concerned.

The Agricultural Tribunal of Investigation.

THE following extract is taken from *Nature*, No. 2850, vol. cxiii. page 867 :—One of the expiring acts of the late Government was to appoint three leading economists—Prof. W. G. S. Adams, Sir William Ashley and Prof. D. A. MacGregor, with Mr. C. S. Orwin as agricultural assessor, to be a tribunal of investigation to inquire into and report on the methods which have been adopted in "other countries" for promoting the prosperity of agriculture and the agricultural labourer. This body has now published a final report. Two interim reports were issued in the spring and autumn of last year. The final report is a bulky volume of some 500 pages. As might have been expected, it is largely devoted to the consideration of political and economic questions, such as the need for maintaining the arable area in the interests of national defence, the promotion of co-operative trading, the advisability of establishing a Wages Board, and so forth. Only a passing reference is

made to education and research, and, under the latter heading, the advocacy of cost book-keeping is, with somewhat doubtful propriety, included. The general impression gained from this report is that, in the opinion of the authors, unless agriculture receives some State or other artificial aid it will be unable to hold its own with the manufacturing industries. Political economy has again justified its sobriquet of "the dismal science." The conclusion is one that a "tribunal" composed of scientific experts could scarcely accept. Less than a century ago agricultural practice was revolutionised by the discovery that "chemicals" could, to some extent, replace the "muckcart"; and the present generation has seen the birth of a science through which, when applied to plant-breeding, equally material advances have resulted. There is no reason why still more epoch-making discoveries should not be made. The entertaining author of *Dædalus* has envisaged one, a potent nitrogen-fixing organism which, though it could not, perhaps, "the multitudinous seas incarnadine and make the green one red," as he has pictured, yet might, as any biologist would admit, prove so potent as a fertilising agent as to alter the whole agricultural outlook.

Agricultural Conditions.

THE weather during March was generally favourable for spring cultivation, except in the northern and north-eastern counties, where for the first two or three weeks of the month the conditions were very stormy and of a wintry character. The month of April was to a great extent cold and dry, and in some districts there were occasional falls of snow. The dry conditions were favourable for the sowing of barley and oats and the planting of potatoes, but the growth of wheat and grass was slow owing to the low temperature and recurring frosts. The weather during May was not particularly favourable for agricultural work. Speaking generally, the month was cold and unsettled, and, while the rains were beneficial to young crops up to a point, the absence of sunshine and warmth retarded growth to a greater or less extent. Turnip sowing was delayed in most districts owing to the difficulty of securing a good seed-bed, and in some parts the work fell more or less into arrear. In the northern counties, Orkney and the Western Islands the conditions during May were drier, and crops and live stock made average progress.

The growth of wheat has been rather backward in most districts, but the braird is generally reported to be healthy except on wet land. The plant is rather thin and weak on some farms in Kincardine and North-East Perth, while in Berwick the crop has never fully recovered from the severe frosts during February, and several fields have had to be ploughed up. According to the estimates furnished by the Board's Crop Reporters, the area under the crop will show a considerable decrease as compared with last year.

Barley is also somewhat backward, but the crop is generally reported to be looking well. In South-West Forfar and North-East Fife the braird is stated to be somewhat discoloured as a result of

the heavy rainfall during May. The estimate of the acreage sown indicates that the "area" will be about equal to that grown last year.

The reports state that oats are the least satisfactory of the grain crops. The plant brairded well in most districts, but grub is prevalent almost everywhere. In Dumbarton, Stirling, Lanark and the south-western counties the damage caused by grub and wireworm is so extensive that re-sowing has been necessary on many farms. In East Aberdeen and Ayr, the area sown is estimated to be less than last year by 5 per cent., and in South-West Fife by 10 per cent., while in Stirling the average is estimated to be greater by 10 per cent. Elsewhere the area under the crop is estimated to be practically the same as in 1923. Beans are generally reported to be looking well, and there is every prospect of a satisfactory crop. Rye-grass and clover have made excellent progress as a result of the heavy rainfall during May. The plants are thick on the ground with a good show of clover, and the hay prospects are very promising.

The weather during April was very favourable for potato-planting. During May, however, operations were interrupted by the frequent rains, and in some cases the seed-bed was rather unsatisfactory. Early varieties were showing above the ground at the end of May; in the south-western counties the plants are stated to be vigorous and healthy and to be making rapid progress. In North-East Aberdeen and Kincardine the area sown is estimated to be greater than last year by 10 per cent., in North-West Aberdeen and North-East Fife by from 5 to 10 per cent., and in East Aberdeen, Berwick and Dumfries by 5 per cent. On the other hand, decreases varying from 5 to 10 per cent. are reported from South-West Aberdeen, North-East Forfar, South-East Perth, South-East Lanark and North Ayr. Taking the country as a whole, the average under the crop would appear to be fully equal to that planted last year. The sowing of swedes was finished or practically finished by the end of May, but the sowing of yellows was delayed in many cases owing to the wet weather, and a considerable acreage had yet to be got in at that date. The sowing of mangolds was practically completed before the end of May in most districts in which the crop is principally grown.

The fruit reports are, on the whole, satisfactory. The blossom on fruit-trees and bushes has been fairly heavy in most districts, although later than usual, and, with warmer conditions, the prospects would be exceptionally good. Apples promise to be an average crop practically everywhere.

Pastures were backward during the spring months, but at the end of May grass was fairly plentiful. In some cases, owing to scarcity of winter keep grazing cattle were leaner than usual when turned out. Dairy cows have made average progress, and the milk yield has increased in most districts. Sheep on arable farms have thriven well, but on hill farms the ewes are not milking well, and are thinner than is usual at this period of the year. On lowland farms the fall of lambs has been about the average, but on hill farms the numbers are below the normal in most districts. The mortality has been higher than usual in many cases owing to

the inclement weather and the shortage of milk; reports of a heavy death-rate have been received from Shetland, Caithness. North Argyll, Ayr, Kircudbright and Wigton. Lambs improved in condition during May, but in some districts they are still rather backward.

The supply of regular workers is generally adequate for present requirements. Experienced ploughmen and boys are rather scarce in Dumfries, while casual labour is short of requirements in West and South Ayr.

RECENT PERIODICAL LITERATURE.

A number of the following extracts and summaries are taken from recent bulletins of the International Institute of Agriculture. Full references to the bulletins, and to the original publications quoted therein, may be obtained on application to the Secretary, Board of Agriculture for Scotland, York Buildings, Edinburgh.

The Yield of Wheat in England during Seven Centuries. *Milton Whitney (Bureau of Soils, Washington, D.C.), Science, Vol. LVIII., No.* 1504, *Lancaster, P.A.*, 1923.—The author discusses the various explanations which have been made relative to the increase of yield of wheat in England, which averaged about $6\frac{1}{2}$ bushels per acre from the thirteenth century until about the year 1550 and then rose steadily to the 32 bushel yield of the present day.

The most important factors for improvement dealt with are:—The inclosure of field farms in the sixteenth and seventeenth centuries; the introduction of clovers, alfalfa and roots and the increase of stock; improved methods of agriculture and the use of fertilisers.

Allusion is made to the average yield of wheat in the United States, which, during the past forty or fifty years has advanced from 12 to about 15 bushels per acre.

It is considered that the low average yield in mediaeval times must be ascribed to the methods, to the system, rather than to any loss of plant food on the farm, and that the increased production of England to-day is due to the methods, system and higher average intelligence of the man who works the soil. King, in his study of Chinese agriculture, estimated that the yield of wheat on a field of a Chinese farmer was no less than 117 bushels per acre.

The author doubts whether such a yield could be obtained under the general economic conditions of the world, but he does not consider that the limit of possible production of the average farmer in England has yet been reached.

Field Trials with Artificial Farmyard Manure. *G. H. Garrad, Agricultural Gazette and Modern Farming, Vol. XCVIII., No.* 2608, *London*, 1923.—Exhaustive investigations have been carried out at the Rothamsted Experimental Station by Richards and Hutchinson to perfect a process whereby straw could be converted into farmyard manure without the agency of livestock. The author gives an account of the testing of this process on some stacks of straw under ordinary farm conditions, and the subsequent utilisation of the artificial farmyard manure.

The stacks were built in the following manner.—Straw was laid down to the depth of about 1 foot and on this was sprinkled powdered chalk, the straw then being sprayed with water until saturated. This was continued until the stack was 10 feet high, when neutral sulphate of ammonia was applied on the top and well washed in until it had thoroughly penetrated the stack.

In the course of a few days the temperature of the stack had risen, and after about three months the straw had broken down into a brown humus, very much like ordinary farmyard manure.

The treatment of 32 tons of straw was carried out in June 1922, on a farm in the Romney March, and five months later the resulting artificial farmyard manure, and also some bullock dung from the same farm, were analysed, the results being as follows:—

	Artificial Farmyard Manure.	Bullock Manure.
	Per cent.	Per cent.
Nitrogen	0·48	0·37
Phosphate (as tri-calcic) . . .	0·16	0·27
Potash	0·27	0·21
Organic matter	12·60	11·10

Field trials were then carried out with oats to compare the values of both manures, adjustments being made so that equal quantities of nitrogen, phosphate and potash were given to each plot.

The resulting yields of spring oats were :—

	Grain.	Straw.
	Qrs. Bus.	Cwt.
Plot. 1. Art. farmyard manure + artificials .	6 6	36¼
„ 2. Art. farmyard manure only . .	6 2	32
„ 3. Bullock dung from manure heap .	5 6	31⅓
„ 4. Rough and dry dung from yard .	4 6	32¾
„ 5. Straw + artificials	4 2	28½

If the straw is not uniformly treated patches will remain unrotted ; however, such straw can be thrown on the next stack and re-treated. An improved method has recently been devised which, it is claimed, makes a more uniform product at a lower cost than that described above. It has been found that 1 ton of straw will make about 3 tons of artificial farmyard manure, the cost of treatment being about 7s. per ton of rotted manure.

The Manurial Properties of Lead Nitrate. *A. R. Berry, Journal of Agricultural Science, Vol. XIV., Part I., Cambridge*, 1924.—Lead compounds in relatively high concentrations are plant poisons, although at low concentrations they may act as stimulants.

The action of lead nitrate upon plant growth is complicated by the fact that: (1) the salt supplies nitrogen in an available form ; (2) its fertilising properties may be destroyed by the toxicity of the lead ; (3) there may be interaction between the salt and the soil constituents. To elucidate some of these points, water culture, pot and field experiments were undertaken.

As a result of the investigations it was found that : lead nitrate as a source of nitrogen for fertilising purposes is equal to nitrate of sodium, when applied in quantities equivalent to those employed in agricultural practice. Its effect on the plant was to produce a slightly broader leaf blade and a deeper shade of green compared with the effect produced by nitrate of sodium. No difference in root development was found. Used in the amounts given in these experiments, no trace of lead could be found in the plant, nor could any lead be detected in a water extract of the soil.

Except in solutions of fairly high concentration, soil absorbs the lead and destroys the toxicity of soluble lead salts.

There was no evidence to show that the addition of lead salts increased the rate of nitrification in soil.

Destruction of Field-Voles in Field and Orchard. *J. Silver, U.S. Dept. Agr. Farmers' Bulletin, No.* 1397, *March* 1924.—The destruction caused by field-voles to trees and pastures in Britian has been discussed in this *Journal* in the series of articles on "Farm Pests." In America similar destruction is caused by closely-related voles (*Microtus* and *Pitymys*),

thousands of valuable trees, both young and mature, being killed every year throughout the United States. In addition, much damage is also caused to pasturage, and to forage, grain and other crops, as well as to tubers, small fruits, flowering plants and shrubbery, the annual loss amounting to millions of dollars. Much of this loss may be avoided by properly organised methods of control. These, shortly stated, consist of (1) removing in autumn rough grass and cover where the voles shelter and feed, (2) treating trees with washes to repel voles, (3) enclosing trees with mechanical protectors, and (4) killing the voles. One of the most successful of the tree washes, on account of its repellent action and of its persistence on the tree, is a mixture of one part of creosote oil with two or three parts of coal tar; but a lime-sulphur wash is also much used, although it is easily washed off and has to be renewed frequently. Voles may be killed by trapping, but much more efficiently by the use of poison baits. As a rule strychnine-soda poison mixtures placed on such a bait as rolled oats have proved most generally useful, and methods are described for the preparation of such mixtures. It is also recognised that a very effective control of voles is established by the preservation of their natural enemies, mammals, birds and reptiles, and of such the United States possess a much greater variety than occurs in Britain.

The Use of Aeroplanes in Pest-Control. *R. B. Coad, E. Johnson and G. L. M'Neil, U.S. Dep. Agr., Dept. Bull., No.* 1204, 1924.—For the first time aeroplanes have been used as agents in pest-control, and the trials have proved so successful that further experiments are certain to follow. With the assistance of the U.S. Air Service, several types of pest were attacked—the larvæ of the catalpa sphinx moth, which were defoliating a grove of catalpa trees, and the cotton boll weevil, which has threatened so seriously the cotton crop in many lands. The aeroplanes were used as dusting machines in place of the ground machines customarily employed. They flew low over the fields affected, emitting from a specially-devised apparatus a fine cloud of lead or calcium arsenates or Paris green, as the requirements demanded. The results, so far as the destruction of the pests was concerned, were satisfactory, and other considerations compare very favourably with the ground machine accomplishments. For example, the cotton leafworm was controlled with an allowance of poison considerably below that necessary when using ordinary dusting machines, and, as regards cost of operating, it is said that there is possibility of pronounced economy as compared with the ground machines. As many as 400 to 500 acres could be dusted in an hour. The initial cost of an aeroplane demands, however, that the work should be undertaken on a community or co-operative basis, and there are other determining conditions which require further study and trial before this interesting method can be adopted wholesale.

Cost of Upkeep of Six-Horse Team Unit in New Zealand. *E. J. Fawcett, New Zealand Journal of Agriculture, Vol. XXVII., No.* 6, *Wellington*, 1923.—In undertaking this work the author's idea was, largely, to suggest to farmers the great importance to themselves of an exhaustive inquiry into the costs of raising farm produce. In working the investigation the following points were kept in view: (1) the cost of maintaining a six-horse team for one year; (2) the cost of cultural operations per acre, calculated at 150, 175, 200, 225, 250 and 275 working days per annum. Twenty-seven farms were selected and visited personally to obtain the required information, and from the data obtained it was shown that the average cost of upkeep of six horses and equipment is £548, 5s. 8d. per annum, or £592, 9s. 8d. for seven horses and equipment.

The power unit is the most expensive item on the farm, and bad management of the team alone will cause a debit balance, as every day the team is idle the cost to the farmer is nearly £2, for which there is no return.

The Use of Hay in the Stable.—The results of some Swedish experiments on the feeding of work-horses were reported in this *Journal* for April 1921 (p. 161 *et seq.*); Swedish Report, No. 253 (1924), by Professor Nils

Hansson, summarises the horse-feeding experiments to date and deals principally with the use of hay in the stable.

In the hay-feeding experiments this fodder was partly replaced by oats (1·2 lbs. = 1 fodder unit) and partly by maize (·95 lbs. = 1 unit). In all the experiments one horse of each working pair belonged to the grain group and the other to the hay group. The experiments were conducted at three different centres. The results are summarised as follows :—

Meadow hay and timothy hay are particularly suitable for work-horses, and for this purpose 2·5 lbs. of hay constitutes a fodder unit. Horses can eat as much as 40-44 lbs. of hay per head per day; but the great bulkiness of the hay and its low concentration causes a considerable reduction in the working capacity of the horses. With an allowance of 26 to 31 lbs. a less but still clearly perceptible reduction in the efficiency of the hay is recorded. The hay has been best utilised when the maximum quantity fed was restricted to 13-18 lbs. Full-grown horses do quite well without hay for long periods if their nutritive requirements are met with other suitable mixtures of foods. The minimum quantity of digestible proteid to feed to work-horses does not exceed ·07 lbs. for each unit in the ration. So hays containing a fair proportion of leguminous plants, also lucerne and clover hay, should be reserved for the cows (which require at least ·1 to ·12 lbs. of digestible proteid for each fodder unit in their ration).

Migration of Ox Warble Larvæ in Cattle. *S. Hadwen and J. S. Fulton, Parasitology, Jan.* 1924.—The province of Saskatchewan, Canada, harbours the same two species of warble-flies that occur in this country, and there also attempts have been made at elucidating the details of the life-history of these pests. The general movement of warble-grubs in the bodies of cattle is now well known, from the first penetration of the skin of the host by the newly hatched larvæ and their migration to the food-canal, to their later return to the surface and their formation of warbles. The authors find that the first part of this succession of migrations, from the skin to the gullet, is accomplished more rapidly than had been supposed, for larvæ scarcely twice the size of a newly hatched individual were found in the chest cavity. Further, post-mortem examination always shows clearly the tracks of the larvæ in the tissues under the skin, and these indicate that the path of least resistance through the connective tissue is followed by the migrants. It was also proved that although no external appearances indicated the presence of boring larvæ below the knee and hocks, internal lesions were plentiful, and those about the heel may be the cause of the lameness frequently exhibited by cattle during the warble season. The presence of warbles seems to develop of itself an immunity in the older cattle, for in animals more than two years old no larvæ were discovered in the gullet nor inside the mucous coat, and this although skin and subdermal lesions characteristic of warble infestation were present.

The Effect of Deficiency of Iron in the Diet of Pigs. *J. P. M'Gowan, and A. Crichton, The Biochemical Journal, Vol. XVII., No.* 2, *Cambridge,* 1923.—In a previous paper, published by Elliott, Crichton and Orr in 1922, attention was drawn to the importance of inorganic constituents in food in connection with rickets in pigs. The authors emphasise the fact that iron may also play an important part in the growth and development of these animals.

The milk of swine contains 0·009 per cent. of iron as compared with 0·002 per cent. in cow's milk, and it may be concluded *a priori* that there is greater need for storing up iron in the body during the suckling period. Hess, Unger and Supplee have shown that the iron content of milk varies with the feed of the animal. Cow's milk contains double the quantity of iron when the animals are fed on pasture than when fed on a mixture of bean meal, linseed meal, hominy, gluten meal and bran, together with dried beet pulp, molasses and straw.

In a large breeding establishment for pigs, the authors observed certain symptoms in pigs three to four weeks old. These symptoms proved fatal, and sudden death was frequent. The sows were kept on pasture until fifteen days before farrowing, and were then shut up and fed on white fishmeal,

bruised meal and brewers' offal, together with an abundant supply of water. This ration, however, lacks iron. When large doses of ferric oxide were given, first to the mothers and then to the pigs when large enough to feed themselves, the cases of sudden death ceased at once.

The authors consider it probable that this disease, according to the observations made (symptoms and post-mortem appearance) corresponds with that caused by cotton seed poisoning, common in the United States and treated with beneficial results by Withers and Carruth by using iron salts.

Rapid Method of Manufacture of Cheddar Cheese. *J. H. Mourad, El Campo, Year* 5, *No.* 85, *Buenos Ayres*, 1923.—A detailed description of the present methods of manufacture of Cheddar cheese and of an improved and far more rapid system employed by the authors.

This new method consists in scalding the curd, and instead of clearing off the whey the vat is covered over for thirty to forty minutes, and uncovered only when the curd has consolidated entirely; after turning and stirring, the cheese is covered and left to ripen, and the taste tested when ripened, the whey is collected and stirring continued without interruption, followed by salting and refrigeration to avoid thickening.

Instead of using a cloth, a double covering is used, so that one thickness will adhere to the cheese, thus acting as a protection from flies.

The system of keeping the curd in whey, stirring from time to time to prevent thickening avoids the necessity of slicing after consolidation. Acidity develops more rapidly in the curd, when covered by a layer of whey, ripening is more speedy, and the cheese can be turned out readily on to the press. Care must be taken, however, to avoid excess of acid, liable to result in a very dry cheese without aroma; the natural consequences of early removal of whey suggest the advisability of taking a small portion and placing on a hot grate and then stretching into an elongated form 2-3 cm.

A New Use for Whey. *Riedel, Molkerei-Zeitung, Year* 32, *No.* 100, *Hildesheim*, 1923.—Whey is a very important by-product of all dairy industries, for, in addition to the albuminoid substances and the lactose present, it also contains a certain amount of fat, a large proportion of the mineral salts of the milk (especially of phosphate of lime, which is of great importance in building up the animal organism), and finally lactic acid, an efficient aid to digestion. It was therefore necessary to find some means of using whey in which all these substances could be turned to account.

As a result of concentrating whey to a high degree, the author succeeded in obtaining a solid stock-feed. The apparatus employed was a caldron into which the whey is thrown upon revolving wings which present a large heating surface.

In this manner it is possible to evaporate at little cost a large amount of the water present in the whey. The evaporation is facilitated by the fact that the lactose solution remains relatively fluid, even at very high concentrations. After the evaporation process is finished, the product is mixed, while still hot, with a certain amount of bran. On cooling, the lactose crystallises out of the mixture, so that the residue is fairly dry. It has, however, been found that a further drying is very advisable; this is effected in the dry-chamber of the evaporator where the mixture can be dried thoroughly without any further expenditure of fuel.

The final product is known as "Molkenkleie" (whey-bran); it is a light-brown powder of pleasant smell and a slightly sweet flavour resembling that of bread. Its percentage composition is as follows: water, 12·60; dry matter, 87·34; (crude protein, 12·47; digestible albumen, 11·20; ash, 9·69; N-free extracts (lactose, starch, fat), 60·98; lactic acid, 2·45; crude fibre, 1·75; fat, 2·04).

This feed, which is very rich, has proved excellent for pigs, and they eat it with avidity. The good conditions of animals given "Molkenkleie" is doubtless to be attributed to the lactic acid present, as it plays a very important part in digestion.

The experiments conducted by Müller and Richter have, however, shown that foods given in the form of "wash" are not as well utilised as mashes. Since whey contains in its natural condition 94–95 per cent. of water, it is evident that the above-described process should be adopted even by dairy-industries keeping a herd of pigs for fattening.

Well-dried "Molkenkleie" will keep as long as required which is a great advantage, because the largest amount of whey is available during the summer months, when owing to the age of the litters there is least demand for pig-feeds, but owing to the fact that whey in its natural condition quickly turns sour, it cannot be preserved for the winter, when it is always in great request.

New Centrifugal Separator. *G. Manrin, Journal d' Agriculture Pratique, Year* 87, *No.* 52, *Paris*, 1923.—M. S. Harpinsky's centrifugal separator consists of a cylindrical basin or tube, 0·05 m. in diameter and 0·30 m. high. The milk to be separated enters by the lower part of the tube, while the separation of the cream from the skimmed milk takes place at the top of the basin, where it is regulated by a screw, as in all other separators.

The high rotation speed (16,000 revolutions per minute) necessitated by the small diameter of the tube is obtained by a hydraulic turbine worked by a jet of liquid furnished by a pump: this renders superfluous the transmission apparatus required in the case of hand-worked engines.

The driving turbine, which is of very small diameter (0·04 m.), is mounted on the axis of the tube. In some cases the force-pump manipulates the pump, the latter being sucked up into a vessel, whence it flows back into the turbine, and afterwards passes into the separating bowl. The milk can, however, be allowed to pass straight into the basin, the water then being used to drive the turbine.

The following results were obtained with this separator when it was tested at the Machine Trial Station (Paris). When the milk to be separated was used as the driving liquid, and flowed back under pressure varying from 12 to 26 kg. per cm^2, the bowl made 12,000 to 16,000 revolutions a minute, while 92 to 103 litres of milk passed through the machine per hour, 91 to 94·6 per cent. of the fat being removed in the cream. If water is employed as the driving liquid, with a pressure of 25 to 35 kg. per cm^2, the bowl revolves 15,000 times per minute, 106 litres of milk are treated, and a little over 94 per cent. of the fat is recovered.

After the cream has ripened, it can be taken up by the pump and forced into a tube of small diameter in which a cylindrical piece of metal is placed, leaving only a narrow ring of space round it; the eddies and jars taking place as the cream is compressed have all the effect of churning, the operation being performed by very simple means. The agglomerated globules and the whey are evacuated from the tube, therefore all that is required in order to obtain butter is to place the product on the table to be worked up.

Inspection of Milk Supplies. *E. Kelly and C. S. Leete, United States Department of Agriculture. Department Circular*, 276. *Washington, D.C.*, 1923.—An official text-book of practical instructions for the control of milk from the three standpoints: *Inspection of dairy-farms* (cows, cow-sheds, dairy utensils, storage rooms, methods of keeping and transporting the products) *and of the dairies* (buildings, water supply, drainage, lighting, machinery, utensils, methods of work, home inspection), *instruction of the Inspecting Staff* (thorough knowledge of stock-breeding and of industrial and commercial methods connected with dairy produce, experience in testing milk and practical knowledge of milk bacteriology and chemistry), *laboratory analysis* (equipment of laboratory, sample taking, methods of analysis, control of pasteurisation and of the almost unavoidable re-contamination taking place after this process). All the persons occupied in the different stages of the industry should be subjected to medical inspection.

The Department of Agriculture and the Official Dairy Instructors' Association have recommended two classification forms for marks which will give the

different results of the inspection of the cow-sheds and dairies. The forms are carefully drawn up, and will set forth the results in question in a detailed manner. These forms have already proved a distinct success, and as soon as a minimum has been fixed by the Municipality, no dairy with marks below this minimum will be allowed to sell milk in the city markets.

The Use of the Self-Feeder for Young Dairy Calves. *A. C. M'Candlish, Journal of Dairy Science, Vol. VI., No. 5. Baltimore,* 1923.—The author, taking as his basis the studies of Eward, Jordan, Fain and Jarnagin, Kildee, and Otis upon the appetising qualities of certain foods, tried to discover how far calves were able to select the rations necessary to supply their needs. The investigators also noted the preference shown by the animals for various concentrates and their salt and water requirements. The experiments were conducted on three calves, an Ayrshire and a Holstein, of the respective ages of thirty-seven and thirty days, both having an initial weight of 50 kg., and a Guernsey calf which was thirty days old and weighed 66 kg. The experiment was divided into two periods each lasting thirty days. At first, the total amount of milk needed by the calves was left at their disposal, but later whole milk was replaced by skim milk. The food was placed in different divisions of the self-feeder, so that the animals could choose what they liked, and consisted of shelled wheat, crushed wheat, ground oats, whole oats, ground maize, linseed cake, wheat, bran, wheat gluten, salt and charcoal. The calves had also free access to lucerne hay of average quality, and for a few hours a day to water. The animals showed a decided preference for whole grain as compared with crushed grain, and ate linseed cake much more readily than wheat bran; they did not like the gluten or the coarsely ground maize as much. The calves showed a capacity to alter their consumption of concentrates to meet their needs; thus, when skim milk was substituted for whole milk, they ate more protein concentrates, in the form of wheat and oats. In this case, they consumed a ration which was proportionately more nutritive than that prescribed by the rules of stock-feeding. According to the modified Wolff-Lehmann feeding standard, the nutritive proportion of the ration during the first period should have been: 1 : 4·3 and during the second period 1·4. The nutritive proportion of the rations consumed by the calves were, however, 1 : 3·4 and 1 : 3·5. In this case, the animals were quite right, for they increased rapidly in weight without putting on too much fat. The calves evidently needed salt and charcoal and also water even when they consumed large quantities of milk.

Improved Methods of Killing Poultry. *El Estanciero, Year XIII., No.* 311. *Montevideo,* 1923.—After drawing attention to the disadvantages of the usual methods of killing poultry (wringing the neck or cutting the throat), which cause the blood to coagulate inside the bird, spoil its appearance, and may result in infection of the wounds, the author advises piercing the brain with a large needle, or the points of the scissors inserted in the middle of the palate, and cutting the large veins at the base of the latter, which is easily done with a pair of scissors. Death is instantaneous, all the blood runs out, and the fowl is more easily plucked. Further, all the above disadvantages are avoided. The author subsequently deals with drawing, plucking, chilling, preparing for the market and packing fowls.

Are Spurs a Disqualification to Hens? *C. Voitellier, La Revue avicole, Year* 33, *No.* 8. *Paris,* 1923.—The author quotes the opinions of various expert stock-breeders as to the correlation between fertility and the assumption of secondary masculine attributes in hens, and concludes that the presence of spurs on hens should be regarded as a defect comparable to any other external malformation in the birds. Recent experiments, especially those conducted by Pèzard, seem to prove without any doubt that the masculinity of certain turkey-hens is due to ovarian insufficiency. Dr Larcher's investigation seems to show that when the ovary no longer exerts its influence upon the organism owing to absence, a condition of physiological rest, atrophy or disease, the secondary male characters show themselves in the females of different birds,

especially in those of certain species. Therefore the author is of opinion that since show-birds are always judged from the utilitarian standpoint, hens with spurs ought to be disqualified, however excellent their other characters may be.

The Rate of Senescence of the Domestic Fowl as Measured by the Decline in Egg Production with Age. *S. Brody, W. Henderson, and H. L. Kempster, The Journal of General Physiology, Vol. VI., No.* 1. *Baltimore*, 1923.—The reduced egg-production of the domestic fowl as it grows older, whether due to a gradual exhaustion of the supply of the oocytes, or to the decrease in the vigour of the organs and tissues regulating egg-laying, or perhaps to both causes combined, may be regarded as a sign of senility, so that the number of eggs produced is an index of the rate at which senescence is proceeding. The authors have collected many data on this subject from which they have constructed an equation, which shows that the total annual egg-production (independent of the age of the hen), is a constant percentage of the number of eggs laid by it in the preceding year.

Thus, by dividing each annual value by the value immediately preceding it, we always obtain the quotient 88, that is to say, the annual egg-production is always 88 per cent. of the egg-production of the previous year, or, in other words, the percentage decrease is constant, and the rate of senescence of the tissues or organs regulating egg-laying follows a definite law. A similar law also governs monomolecular chemical reactions; thus we are induced to believe senescence to be a physico-chemical process determined and limited by chemical reaction.

Vitamines and Their Relation to Poultry Diseases. *F. B. Beaudette, The National Poultry Journal, Vol. IV., No.* 188. *London*, 1924.—The author studies the effects produced on the health of poultry by the lack of the different vitamines. A deficiency of vitamine *A* induces xerophthalmia, slow growth, and symptoms of languor together with loss of flesh frequently accompanied by diarrhœa. The comb turns pale or bluish; in the more advanced stage of the disease, the eye is surrounded by a whitish, easily detached deposit with no special odour. Post-mortem examination reveals a contracted œsophagus on the upper or lower portions of which appear small whitish bodies of the size of a millet seed. The kidneys, ureters, and heart are filled with a white deposit of urates; the liver looks as if it were powdered with talc. All that is needed to cure these symptoms is a diet rich in vitamine *A*; their occurrence can be prevented by giving the poultry green food in summer and germinated oats during the winter. The absence of vitamine *B* causes poly neuritis or beri-beri, especially in chicks; the head is thrown backwards, and the legs become paralysed. The sick bird is always very thin. Post-mortem examination shows the muscles of the chest to have become almost entirely atrophied; the internal organs, especially the muscles, assume a dark colour. Power of locomotion can be restored to the bird after a few hours by giving it a solution of yeast; and within the next twenty-four hours all the symptoms, with the exception of the emaciation, will have disappeared.

A deficiency in vitamine *C* gives rise to scurvy, but without producing any of the characteristic symptoms or anatomical lesions usually accompanying that disease. Where vitamin *D* is absent rachitism appears, especially in chickens, which, though they appear strong and vigorous, are unsteady on their legs. This disease can be prevented by adding 5 per cent. of cod-liver oil to the ration. It should be remarked that chicks must have air and exercise. The experiment seems to prove that if hens are fed a ration poor in vitamines, the number of fertilised eggs failing to hatch out is larger than when the diet of the birds has been normal and complete.

Correlation between White, Yolk and Shell of the Eggs of Various Birds. *W. Friese, Zeitschrift für Untersuchung der Nahrungs- und Genussmittel, Vol. XLVI., No.* 1. *Berlin*, 1923.—Report of observations made by the author giving in tabular form the total and absolute weight and proportions of the various parts of the eggs of hens, geese, ducks, turkeys, pigeons, guinea

fowl, pheasants, gulls, lapwings, blackbirds, sparrows, canaries. The following data are given with reference to domestic birds :—

	Hens.	Geese.	Ducks.	Turkeys.
	Grams. Per Cent.	Grams. Per Cent.	Grams. Per Cent.	Grams. Per Cent.
Whites	56·22	52·23	50·03	56·72
Yolks	31·72	32·72	38·02	32·51
Shell	12·06	14·05	11·95	10·77
Total weight . .	57·12	137·38	78·11	92·93

Super-Grafting. Effect of the Scion on the Stock. *P. Passy, Journal de la Société Nationale d'Horticulture de France, Series* 4, *Vol. XXIV. Paris,* 1923.—I. Super-grafting consists in applying another fruit-bearing graft to the first scion inserted in the stock. The resulting individual is thus formed from : (*a*) the stock which supplies the root system ; (*b*) the intermediate system ; (*c*) the scion forming the fertile crown.

This method of grafting is adopted in the nursery in order quickly to get rid of a bushy, thorny individual, and obtain a more shapely tree. The pear-tree when growing on its own roots is bushy, and has a number of thorny branches. If during its second or third year in the nursery a shield-graft is made with a scion from a vigorous thornless variety of pear, a straight stem is produced upon which the fruit-bearing variety can be grafted ; in this way the nurseryman disposes of a troublesome tree and saves time. Pear-trees growing on their own roots are very dissimilar, and would produce plots lacking in homogeneity ; this can, however, be remedied by shield-grafting ; a scion producing a fine stem should be inserted in the stock while it is still very young.

Super-grafting has also been recommended for imparting vigour to weakly varieties ; it is especially advisable when low-growing espaliers are required. A vigorous scion is grafted on the quince, and in the autumn of the first year shield-grafts of the delicate variety are inserted in the first scion at about 30-40 cm. from the ground. In this manner the strong-growing intermediate graft is reduced to some centimetres of wood which bear no leaves, and thus seem to exert no influence upon the fruit-bearing scion. It is, however, well-known that some varieties of pear do not graft well on the quince, although the grafts take satisfactorily if another tree is selected for the stock. Therefore by the process of intermediate grafting, it is possible to grow upon the quince a variety that ought to have been grafted on a stock growing on its own roots.

Instead of inserting the fruit-bearing scions at a height of 40-30 cm. from the soil, and thus at once suppressing the vigorous variety, the first change in the tree may be obtained from the latter which can be allowed to make 1-1·50 m. of wood. Owing to its special properties this strong-growing graft will cause the stock to develop and strengthen its root-system, so that when the delicate variety is grafted at this height the trees will have already acquired a vigorous growth from which the scions will benefit.

II. As regards the possibility of the graft exercising a direct action upon the root-system of the stock, the author states that, at all events at the beginning, the effect of the graft is easily recognised when the pear is grafted on the quince. It has been found that if on the same plot varieties of pear with scions that hardly ever branch to a great extent, such as *Beurré Hardy*, *Doyenné du Comice* and *Curé*, are grafted on varieties producing many branched shoots like *Doyenné d'hiver*, *Beurré d'Hardenpont*, the root-system of the varieties with unbranched grafts is poorly developed, whereas in the case of those with much branched shoots, the number of roots is much larger and the rootlets do not penetrate so deeply into the soil.

The Burmester Plough. *H. Burmester, Die Landmaschine, Year* 3, *No.* 83. *Berlin*, 1923.—The author describes a plough that he has invented, and the manner in which it works. The object in devising the implement was to turn the slice not all at once, but in such a manner that the lower, and much the larger portion should be turned over on the furrow, while the upper part, which is composed of the dung spread on the field and of the superficial stratum that must be broken up to form the seed-bed, is turned over upon the deeper-lying slice. This insures the seed-bed being in the best chemical, physical and biological condition ; further, it allows the microflora of the soil to develop rigorously, while the manure finds its way to the layer where it can become completely incorporated in the soil, and be assimilated by the plants.

The Burmester plough is fitted with two shares ; the front and upper share lifts the superficial layer of the soil on which rests the manure and carries it to one side, while the lower share cuts and turns the deeper-lying slice ; then the upper layer is inverted so that the manure lies between the upper and the lower slice. The back and lower share is inserted as vertically as possible in order to turn over and break up the bottom part of the slice properly. The depth of the ploughing is regulated by the same method as that adopted in the case of deep-working Sack, or Eckert, ploughs.

Cold Storage as an Insecticide. *A. O. Carson and P. Simmons, Jour. Agr. Res. Washington, Jan.* 1924.—Quantities of the peas and beans imported into Britain are destroyed by various species of pea and bean weevils, the grubs of which burrow into and feed upon the substance of the peas and beans. It has long been known that storage of the legumes at low temperatures had the effect of preserving them from attack, but it has only been recently recognised that cold storage also brings about the actual destruction of the weevils present in the seeds. To be thoroughly effective such destruction must effect not adult beetles only but eggs and larvæ as well, and it was to discover the temperatures at which complete obliteration of all the stages of the beetles took place that the authors devised their experiments. Two species of weevils were subjected to experiment—*Bruchus obtectus* and *Bruchus quadrimaculatus*. As regards the former it was discovered that very satisfactory control of larvæ, pupæ and adults was accomplished by subjecting the beans to a temperature of 32° F.—the freezing point of water—for fifty-six days, or at a slightly higher temperature, 36° F., for a slightly longer period, sixty-six days. Considerably shorter periods of exposure rendered the adults incapable of reproduction. As regards the second weevil, all stages were killed at 32° F. for thirty-two days. The eggs were more susceptible to cold than the other stages, for at 32° F. they were killed by four days refrigeration.

Straw-Rope Making. *L. Brasse-Brossard, La Vie technique et industrielle, Year* 5, *No.* 57, *Paris*, 1923.—The author draws attention to the importance of a new industry, the manufacture of straw ropes. These ropes find a ready market in England where they are employed for packing delicate or dangerous goods and as insulating material in milling. The process of manufacture is described and the best straw to use (rye straw is recommended).

The Production of Air-Dried Peat. *Department of Scientific and Industrial Research, Report of the Fuel Research Board for the Years* 1922–1923, *London*, 1923.—Mechanical methods of producing air-dried peat in Europe and Canada are dealt with in this report, and the difficulties entailed in the production and the possibilities of large scale projects. Investigations are described undertaken by the Fuel Research Board with reference to the preparation of air-dried machine peat in an Irish bog, employing Continental methods but on a slight scale. Results confirm former observations that machine peat dries more uniformly than slane-cut peat and is superior to the latter material. A detailed and critical description is given of the peat industries in Northern Germany, Sweden and Canada.

False Ribs in Cattle: Their Unimportance from the Stock-Breeding Standpoint. *P. Navez, Annales de Medecine Vétérinaire, Year 68, Nos. 8 and 9, Ixelle-Brussels,* 1923.—The author, after mentioning the great importance attributed at shows to false or abortive ribs in cattle, and stating that the possession of such anomalous structures disqualifies animals for registration in the Herdbooks, passes on to study, with the help of comparative anatomy and embryology, the meaning of the anatomical anomalies, in order to discover their importance from the stock-breeding standpoint. The "floating rib" may represent the thirteenth rib that has become abortive in the course of development, or more rarely, is a supernumerary fourteenth rib articulating with the fourteenth dorsal vertebra, which is also supernumerary, or it may be a real, or apparent, prolongation of the first lumbar vertebra. It is only by examining the skeleton that it is possible to detect the relation between the upper end of the false rib and the vertebrae of the spine and thus determine its anatomical origin. No clue is afforded by the study of the live animal, therefore this anomaly must be regarded as an entirely exozoognostic fact.

In certain countries, at various times, false ribs have been considered to be a defect excluding the animals from use as breeding-stock. The author gives the opinion held on the subject in some parts of Belgium and Switzerland, referring to the former decisions of two Conferences at Woedensteil and Brugg respectively which were against giving prizes to abnormal animals. In Germany, however, false ribs are regarded as of no importance, as may be seen by reference to two well-known works on cattle-breeding (Pusch, *Die Burteilungslehre des Rindes*, Berlin, 1896, and Hansen, *Lehrbuch der Rinderzucht*, Berlin, 1922).

The author declares himself to be of the opinion that false ribs are merely an anomaly of growth with no effect on function, and should only be regarded as a defect from the aesthetic point of view.

OFFICIAL ORDERS AND CIRCULARS.

THE following notices were issued recently by the Board :—

Names of the Varieties of the Potato and their Synonyms.

The Board of Agriculture for Scotland desire to announce that they have issued in the form of a booklet of handy pocket size a revised edition of their List of Names of the Varieties of the Potato together with their Synonyms. The list contains the names of 1701 varieties which have been grown or tested in Great Britain, and indicates also whether the varieties are immune from or susceptible to wart disease in all cases where this is definitely known. The list should prove of value to potato growers and merchants.

Copies may be obtained on application to the Secretary, Board of Agriculture for Scotland, York Buildings, Queen Street, Edinburgh: price 2s. 6d. post free.

Agricultural Credit Societies.

The Board of Agriculture for Scotland desire to remind farmers, small holders, allotment holders and other agriculturists of the facilities which are available under section 2 of the Agricultural Credits Act, 1923, for obtaining credit to meet (1) current seasonal outlays as for the purchase of seeds, fertilisers, feeding stuffs, or (2) more occasional expenditure on live stock, implements and machinery. Advantage can be taken of these facilities by the establishment of Agricultural Credit Societies having for their object or one of their objects the making of short term loans to their members for such agricultural purposes as may be approved by the Board.

The Board have not approved any definite set of purposes, but the foregoing list may be taken as covering their conception of such agricultural purposes as can be served by loans issued for periods varying from

six months to five years, which is the extreme limit contemplated for the purposes of short term credit.

With a view to assisting the formation of such societies, a set of model rules has been prepared by the Board setting out in detail the constitution of an Agricultural Credit Society, its method of operation, and the manner in which it must be conducted to conform with the statutory provisions. These rules are obtainable from H.M. Stationery Office, 120 George Street, Edinburgh (price 1s. net; post free 1s. 0½d.), in a form suitable for submission for registration under the Industrial and Provident Societies' Acts.

After registration, an Agricultural Credit Society is entitled to apply to the Board for advances up to an amount equal to one pound for every one pound share held by members of the Society. The Government has decided that in future advances to Agricultural Credit Societies should be made at bank rate (*i.e.*, the rate at which the Bank of England discounts bills), with a minumum of 4 per cent. As the bank rate is at present at that figure, this means that the interest payable will be at the rate of 4 per cent. per annum.

There is no limit to the number of shares that may be issued by an Agricultural Credit Society provided that a sum of five shillings is paid on each share. The advances obtained from the Board, with the addition of the paid-up share capital, form the funds out of which the Society may make loans to its members. It is provided by the Act that these loans may be of such amount as the Society thinks fit, but so that an advance to any member shall not exceed one-tenth part of the share capital of the Society, or an amount equal to five pounds for every one pound share held by the member.

Those desirous of forming a Society or of obtaining further information on the subject should communicate with the Secretary, Board of Agriculture for Scotland, York Buildings, Edinburgh.

Loans to Agricultural Co-operative Societies.

The Board of Agriculture for Scotland announce that arrangements have now been completed for the application to Scotland of a scheme for the advance of loans to Agricultural Co-operative Societies to assist them in meeting expenditure on buildings, plant or equipment required for the establishment or development of productive co-operative enterprises such as milk dépots, bacon factories, etc., connected with the agricultural industry. The adoption of this scheme has been approved with a view to giving effect to recommendations made in the Reports of the Departmental Committee on the Distribution and Prices of Agriculture Produce, that loans should be advanced from State funds towards the capital expenditure involved in the promotion and development of undertakings organised on a co-operative basis for the sale, preparation and manufacture of farm products.

The Board are prepared to receive applications from Agricultural Co-operative Societies for assistance under this scheme. Each application should be accompanied by a full statement of the society's proposals, including information regarding the support, financial or otherwise, which has been promised by the members of the society. The extent of the assistance to be given by the Board, and the exact terms of any loan that may be approved, will be decided after completion of any enquiries which the Board may think it necessary to make in examining the merits of the application; but in order to enable Agricultural Co-operative Societies to consider the matter, the following statement giving a general outline of the conditions under which advances will be made has been prepared:—

(1) To the extent of such funds as may be placed at their disposal the Board of Agriculture for Scotland will make loans to Co-operative Societies registered under the Industrial and Provident Societies Act. In order that a society may be eligible for a loan, its share capital must be mainly contributed by agriculturists, and the proportion of such capital paid up must be not less than 5s. per £1 share.

(2) In the case of newly-formed societies, loans will be made by the Board for the purpose of assisting the applicants in erecting or acquring suitable premises and in providing plant.

(3) In the case of existing societies already carrying on operations, loans will be made for the purpose of assisting the applicants in improving or extending their premises and plant, provided that the Board is satisfied as to their financial position.

(4) The amount of the loan from the Board will not exceed, in the case of a new society, half the total capital considered by the Board to be necessary for the proper equipment and working of the society, or the sum which would be advanced by a willing lender to a willing borrower on the security of such heritable subjects as the society may possess or acquire for the purposes of the undertaking, whichever is less, and no loan will be granted until the Board are satisfied that the remaining capital required for the proper equipment and working of the society will be available.

(5) In the case of an existing society, the amount of the loan from the Board will not exceed half the sum estimated to be spent on the improvement or extension of premises and plant.

(6) The maximum amount of the loan made by the Board to any single society will not exceed £10,000.

(7) Security for the loan made by the Board will be provided by a bond on such heritable subjects as the society may possess or acquire or, subject to prior Treasury approval, in such other manner as the Board may require.

(8) The loan will be repayable in equal half-yearly instalments of principal with interest at the rate of 5 per centum per annum on outstanding balances of the loan over a period of not more than twenty years. The first instalment of repayment of principal and interest will be made thirty months after the date when the loan is actually paid over by the Board, or, if it is paid over in more than one instalment, thirty months after the date when the first instalment is paid over, and will consist of one half-yearly instalment of principal with interest for six months on the whole amount of the loan.

If a society so desires, the Board will be prepared to consider proposals for other methods of payment of interest and repayment of principal, provided that they do not involve greater financial concessions than the method set out above.

(9) There shall not be paid by way of interest on the share capital of the society any sum in excess of an amount equal to 5 per centum per anuum on the paid-up share capital.

(10) The Board shall have the right, if they so desire, to appoint a representative on the committee of management of any society to which a loan is made. He will report regularly to the Board upon the manner in which the business of the society is conducted.

(11) The society shall cause an audit of accounts to be made annually, and a copy of the auditor's report and of the account shall be supplied to the Board, if they so desire. The books of the society shall be open to inspection by an officer of the Board at any time upon due notice.

(12) The Board reserve the right to require at any time the immediate repayment of the outstanding principal of the loan together with interest payments due to date, if they are not satisfied with the manner in which the affairs of the society are conducted.

Applications for loans under this scheme and all enquiries on the subject should be forwarded to the Secretary, Board of Agriculture for Scotland, York Buildings, Queen Street, Edinburgh.

STATISTICS.

PRICES of AGRICULTURAL PRODUCE and FEEDING STUFFS in March, April and May 1924.

AVERAGE PRICES OF LIVE STOCK IN SCOTLAND.

(Compiled from Reports received from the Board's Market Reporters.)

Description.	MARCH.			APRIL.			MAY.		
	1st.	2nd.	3rd.	1st.	2nd.	3rd.	1st.	2nd.	3rd.
FAT STOCK :—									
CATTLE—	per cwt. l.w. s. d.	per cwt. l.w. s. d.	per cwt. l.w. s. d.	per cwt. l.w. s. d.	per cwt. l.w. s. d.	per cwt. l.w. s. d.	per cwt. l.w. s. d.	per cwt. l.w. s. d.	per cwt. l.w. s. d.
Aberdeen-Angus ..	65 0	60 2	41 8	64 9	60 2	41 7	66 5	61 5	43 11
Cross-bred (Shorthorn)	62 8	57 9	38 0	62 5	57 2	38 5	63 10	58 9	40 7
Galloway	64 0	58 5	...	63 6	57 5	...	67 9	61 4	...
Ayrshire	...	...	...	...	...	...	59 0	51 0	36 0
Blue Grey	...	...	...	...	...	...	...	...	...
Highland	64 6	...	...	...	...	...	68 6	..	...
	per lb. d.	per lb. d.	per lb. d.	per lb. d.	per lb. d.	per lb. d.	per lb. d.	per lb. d.	per lb. d.
VEAL CALVES . ..	15¼	7½	5¼	13¾	6½	4½	18	9½	6¾
SHEEP—	under 60 lb. per lb. d.	60 lb. and upw'ds. per lb. d	Ewes per lb. d.	under 60 lb. per lb. d.	60 lb. and upw'ds. per lb. d.	Ewes per lb. d.	under 60 lb. per lb. d.	60 lb. and upw'ds per lb. d.	Ewes per lb. d.
Cheviot	16	15	12½	16¼	15	12¼	18½	17¾	13¼
Half-bred	15½	15	11½	15¾	15	11½	17½	16¾	12¼
Blackface	16¼	14½	11½	16	14½	11½	17¾	16	12½
Greyface	16	14¾	9¼	16	15	9¼	17¾	16¾	10¼
Down Cross	16	15	...	15¾	14¾	...	17¾	16¾	...
PIGS—	per stone. s. d.	per stone. s. d.	per stone. s. d.	per stone. s. d.	per stone. s. d.	per stone. s. d	per stone. s. d.	per stone. s. d.	per stone. s. d.
Bacon Pigs	10 3	9 0	6 6	10 7	9 1	6 6	10 10	9 4	...
Porkers	10 8	9 6	...	10 11	9 8	...	11 1	10 0	..

AVERAGE PRICES OF LIVE STOCK IN SCOTLAND—*continued.*

Description.	March. 1st.	March. 2nd.	March. 3rd.	April. 1st.	April. 2nd.	April. 3rd.	May. 1st.	May. 2nd.	May. 3rd.
STORE STOCK :—									
STORE CATTLE—	per head. £ s.	per head. £ s.	per head. £ s.	per head. £ s.	per head. £ s.	per head. £ s.	per head. £ s.	per head £ s.	per head. £ s.
Aberdeen-Angus :									
Yearlings	18 8	15 12	14 0	19 16	16 17	13 14	19 15	16 19	13 14
Two-year-olds ...	27 15	24 3	23 12	28 2	24 1	18 6	29 0	23 17	17 15
Cross-bred (Shorthorn) :									
Yearlings ...	17 15	14 13	12 0	18 2	15 9	13 5	19 0	15 13	13 0
Two-year-olds ...	26 14	21 15	...	26 3	21 1	18 5	26 19	22 2	18 15
Galloway:									
Yearlings	19 0	...	..	18 15	14 10	...	18 10	...	...
Two-year-olds ...	...	22 3	...	36 10	22 0	...	31 5	22 0	.
Ayrshire :									
Yearlings	..	...	...	12 0	...	...	12 12	...	...
Two-year-olds ..	...	...	...	...	...	...	...	...	...
Blue Grey :									
Yearlings	...	...	...	..	..		.	...	...
Two-year-olds ...	..	.	.		..	...	...	...	..
Highland :									
Yearlings	...	...	...	...	...	...	14 2	12 12	12 0
Two-year-olds ...	...	...	...	22 10	...	...	19 5	15 5	14 0
Three-year-olds ...	...	...	...	...	...	...	23 19	19 13	..
DAIRY COWS—									
Ayrshire :									
In Milk	35 18	27 6	21 10	34 4	25 0	18 14	33 19	25 8	17 18
Calvers	35 13	25 17	19 10	32 7	24 10	18 2	34 7	25 7	17 10
Shorthorn Crosses :									
In Milk	41 11	31 18	22 2	40 16	31 10	21 16	41 12	31 3	21 1
Calvers	36 16	28 6	19 14	35 17	27 4	18 15	36 12	27 18	19 10
STORE SHEEP—	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.
Cheviot Hoggs ...	61 9	47 1	36 8	63 2	51 10	40 0	62 10	49 10	42 6
Half-bred Hoggs ...	78 4	61 5	59 3	81 8	64 6	61 9	87 4	69 5	55 5
Blackface Hoggs ...	46 8	34 0	24 3	46 0	33 11	25 8	51 11	41 10	29 8
Greyface Hoggs ..	64 7	52 8	47 0	65 7	54 1	48 2	74 11	61 7	49 3
Down Cross Hoggs	...	69 8	60 6	...	68 9	57 0	75 6	66 9	...
STORE PIGS—									
(6 to 10 weeks old)	33 9	19 5	...	30 1	19 1	...	31 3	19 4	...

AVERAGE PRICES OF DEAD MEAT AT DUNDEE, EDINBURGH, AND GLASGOW.

(Compiled from Reports received from the Board's Market Reporters.)

Description.	Quality.	March.			April.			May.		
		Dundee.	Edinburgh.	Glasgow.	Dundee.	Edinburgh	Glasgow.	Dundee.	Edinburgh.	Glasgow.
		per lb. *d.*	per lb. *d.*	per lb. *d.*	per lb. *d.*	per lb. *d.*	per lb. *d.*	per lb. *d.*	per lb. *d.*	per lb. *d.*
BEEF :—										
Home-fed—										
Bullock or Heifer ..	1	9½	10	11½	9⅜	9⅝	11¼	10	10¾	11½
	2	9¼	8¾	9⅞	9	8⅝	9⅝	9½	9½	10¼
Bull	1	8¼	8⅝	8⅜	8⅛	8⅜	8⅜	9	8¾	8½
	2	7¾	7⅛	7¼	7⅝	7¼	7⅜	8½	8	7¾
Cow	1	6⅝	6⅝	8	6⅝	6⅜	7¼	7½	6⅞	8⅛
	2	6	5¼	6½	6⅛	5¾	6¼	7	6⅛	6⅜
Irish—										
Bullock or Heifer ...	1	..	...	9⅞	..	...	10	...	...	10⅜
	2	...	..	8¼	...	...	9⅛	...	...	9⅝
Bull	1	...	...	7⅝	...	...	8	...	...	8
	2	...	...	6⅞	...	...	7¼	...	.	7
United States & Canadian—										
Killed at Birkenhead	1	...	..	9⅜	..	...	...	...	..	.
	2	...		9¼	...	...	...	...	...	..
,, Glasgow ...	1	...	...	...	.	...	9½	...	...	10
	2	. .	...		...	...	9	...	...	9
Argentine Frozen—										
Hind Quarters ...	1	...	6¼	. .	...	6¼	...	...	7⅛	..
Fore ,, . .	1	...	4⅞	...	...	4⅞	...	..	5	
Argentine Chilled—										
Hind Quarters ...	1	...	6	6	..	7½	7⅝	...	7⅜	7⅞
	2	...	.	5¾	.	...	...	...	...	7⅜
Fore ,, ...	1	...	4½	4⅝	...	5	4⅞	..	5	4⅞
	2	...	...	4¼	..	.	4⅜	...	...	4⅝
Australian Frozen—										
Hind Quarters ...	1	...	...	5½	...	...	5½	...	...	5¼
	2	...	...	...	...	...	...	..	...	...
Fore ,, ...	1	...	...	...	...	...	...	..	...	. .
	2	...	...	...	...	...	.	...	...	...
MUTTON :—										
Hoggs, Blackface ...	under 60 lb.	14	12⅝	14¾	14¼	12¼	14¼	16¾	15⅞	16½
	60 lb. & over	13	11⅜	12¾	13¼	11½	12½	15¾	15	15¼
,, Cross	under 60 lb.	14	13	14⅜	14¼	13	13½	16¾	16⅜	16⅛
	60 lb. & over	13	11⅝	13	13¼	12	12¼	15¾	15½	14¾
Ewes, Cheviot ...	1	11	9⅜	11⅛	11	9⅝	10⅝	12¾	10⅝	13⅛
	2	10	9	9¾	10⅛	...	9⅜	11¾	...	12¼
,, Blackface ...	1	11	...	10⅝	11	...	10¼	12¾	...	12¾
	2	10	...	9	10⅛	..	8¾	11¾	...	11¾
,, Cross	1	8	9	9	8⅛	9½	8⅜	9	10	9⅝
	2	7½	...	7⅞	7⅜	...	8	8	..	8¾
Argentine Frozen ...	1	...	7¾	7½	.	6⅜	6⅜	...	6⅜	6½
	2	...	...	..	...	.	...	...	6	5¾
Australian ,, ...	1	..	...	7	...	...	6	...	..	5¾
	2	...	...	...	...	...	...	..	. .	5½
New Zealand ,, ...	1	...	...	...	...	...	...	...	...	...
	2	..	...	..	...	...	...	..	. .	...
LAMB :—										
Home-fed	1	...	...	...	...	...	...	...	...	...
	2	...	...	..	...	...	...	...	...	...
New Zealand Frozen	1	...	11⅞	11½	...	11	10⅞	...	11¾	11½
	2	...	...	..	...	10⅝	10½	...	11	10⅝
Australian ,, ..	1	...	...	10½	..	...	10¼	...	...	10½
	2	...	...	...	..	...	10	...	...	9⅞
Argentine ,, ...	1	...	10¼	...	...	9¾	9	...	9⅜	9¼
	2	...	9¾	...	...	...	...	...	...	...

AVERAGE PRICES OF PROVISIONS AT GLASGOW.

(Compiled from Reports received from the Board's Market Reporter.)

Description.	Quality.	March. s. d.	April. s. d.	May. s. d.
BUTTER:				
Irish Creamery... per cwt.	1	...	167 4	175 0
" " (Unsalted) "	1	...	174 8	181 6
Danish ... ... "	1	215 9	179 0	207 9
" (Unsalted) "	1	225 9	189 0	217 9
New Zealand ... ... "	1	188 3	167 2	181 6
CHEESE:				
Cheddar ... ... "	1	115 6	102 7	96 0*
	2	110 6	96 10	...
Dunlop ... ... "	1	107 6	98 0	78 0*
	2	104 9	95 0	74 0*
Canadian ... ... "	1	104 6	101 7	104 0
New Zealand (Coloured) "	1	97 9	93 7	94 6
New Zealand (White) "	1	97 6	93 2	94 9
BACON:				
Ayrshire (Rolled) ... "	1	139 0	141 7	146 0
Irish (Green) ... ... "	1	...	...	...
" (Dried or Smoked) "	1	118 6	122 10	132 6
" (Long Clear) ... "	1	108 6	114 0	127 0
Wiltshire (Green) ... "	1	...	...	...
" (Dried or Smoked) "	1	...	...	...
American, Long Clear Middles (Green) "	1	71 9	74 2	76 6
American, Short Clear Backs ... ... "	1	80 6	80 0	82 6
American, Bellies... "	1	88 0	88 0	88 0
" Sides ... "	1	...	...	...
" Cumberland Cut "	1	67 9	67 7	69 6
Canadian, Sides ... "	1	80 0	79 7	83 6
Danish, Sides ... "	1	93 0	90 2	97 9

Description.	Quality.	March. s. d.	April. s. d.	May. s. d.
HAMS:				
Irish (Smoked) per cwt.	1	142 6	148 10	195 6
American, Long Cut (Green) ... ... "	1	82 6	81 5	83 3
	2	78 0	78 0	80 6
American, Short Cut "	1	84 0	82 5	87 0
	2	...	...	85 0
Canadian, Long Cut "	1	...	...	...
EGGS:				
Country ... ... per doz.	1	1 11	1 5	1 6
	2	1 9	1 3	1 4
Irish ... ... per 120	1	16 0	13 2	13 8
	2	15 0	12 6	12 11
" (Duck) ... "	1	20 9	15 5	14 3
	2	20 6	14 7	13 9
Danish ... ... "	1	17 8	15 4	15 11
	2	15 8	13 8	14 9
Dutch ... ... "	1	15 5	...	14 0
	2	14 8	...	...
Dutch (Duck) ... "	1	18 0	13 11	...
	2	...	...	...
Egyptian ... ... "	1	11 5	8 7	8 6
	2	10 7	7 8	7 6
Moroccan ... "	1	12 0	...	...
	2	...	...	...
Polish ... ... "	1	...	...	12 5
	2	...	...	11 6
Russian ... ... "	1	...	...	13 6
	2	...	...	11 9

* New Cheese.

Average Prices of Potatoes at Dundee, Edinburgh, and Glasgow.

(Compiled from Reports received from the Board's Market Reporters.)

Markets.	Quality.	Late Varieties. Red Soils. Langworthy and Golden Wonder.	Red Soils. Other.	Other Soils. Langworthy and Golden Wonder.	Other Soils. Other.
		per ton. £ s. d.	per ton. £ s. d.	per ton. £ s. d.	per ton. £ s. d.
MARCH.					
Dundee	First	...	..	...	9 18 0
	Second	...	...	...	9 10 0
Edinburgh	First	...	...	11 10 0	9 16 0
	Second	...	...	...	...
Glasgow	First	13 9 0	11 9 0	12 3 0	9 18 0*
	First	...	...	...	10 13 0†
APRIL.					
Dundee	First	...	...	...	10 11 0
	Second	...	...	...	8 10 0
Edinburgh	First	...	...	13 8 0	12 4 0
	Second	...	...	...	...
Glasgow	First	13 18 0	12 2 0	12 12 0	11 7 0
	Second	...	...	...	...
MAY.					
Dundee	First	...	...	...	14 0 0
	Second	...	...	...	...
Edinburgh	First	...	...	...	15 0 0
	Second	...	...	...	...
Glasgow	First	16 2 0	15 5 0	15 10 0	14 5 0
	Second	...	...	...	...

* Arran Chief. † Kerr's Pink.

AVERAGE PRICES OF ROOTS, HAY, STRAW, AND MOSS LITTER, AT DUNDEE, EDINBURGH, AND GLASGOW.

(Compiled from Reports received from the Board's Market Reporters.)

Markets.	Quality.	Roots. Carrots. per ton. s. d.	Roots. Yellow Turnips. per ton. s. d.	Roots. Swedes. per ton. s. d.	Hay. Rye Grass and Clover. per ton. s. d.	Hay. Timothy. per ton. s. d.	Straw. Wheat. per ton. s. d.	Straw. Barley. per ton. s. d.	Straw. Oat. per ton. s. d.	Moss Litter. per ton. s. d.
MARCH.										
† Dundee ...	1	...	...	17 9	136 11	...	88 9	...	86 3	...
	2	...	...	...	125 0	...	...	...	..	..
‡ Edinburgh	1	...	...	...	112 6	..	60 8	58 9	66 11	...
	2	...	...	...	..	...	...	...	65 0	...
$ Glasgow ..	1	...	...	...	...	...	...	...	...	40 0
	2	...	...	...	...	...	...	...	...	...
APRIL.										
† Dundee ...	1	...	...	22 5	134 0	...	86 3	86 11	89 6	46 3*
	2	...	...	...	...	...	..	...	..	...
‡ Edinburgh	1	...	...	...	110 0	...	58 0	56 3	61 0	45 0**
	2	...	...	...	...	...	...	...	60 0	40 0††
$ Glasgow...	1	...	...	...	105 0	110 0	55 0	52 0	60 7	40 0
	2	...	...	...	...	...	...	..	...	...
MAY.										
† Dundee ...	1	...	...	24 5	130 0	...	85 10	85 8	89 5	46 0*
	2	...	...	...	...	...	...	...	...	...
‡ Edinburgh	1	...	...	...	111 11	...	57 6	...	60 0	45 0**
	2	...	...	...	...	...	...	...	...	40 0††
$ Glasgow...	1	...	...	...	106 3	110 0	56 3	40 0	62 6	40 0
	2	...	...	...	...	...	...	...	...	...

† Quotations for Hay and Straw, baled and delivered. * At Quay.
‡ „ „ „ delivered loose in town. ** Dutch.
$ „ Baled Hay and Straw, f.o.r. †† Home.

AVERAGE PRICES OF FEEDING STUFFS AT GLASGOW AND LEITH.

(Compiled from Reports received from the Board's Market Reporters.)

Description.	March.		April.		May.	
	Glasgow.	Leith.	Glasgow.	Leith.	Glasgow.	Leith.
	per ton. £ s. d.	per ton £ s. d.	per ton. £ s. d.	per ton. £ s. d.	per ton. £ s. d.	per ton. £ s. d.
Linseed Cake—						
Home	...	12 7 6	12 6 8	11 18 0	12 0 8	11 10 0
Foreign	13 0 0	...	12 4 6	...	11 11 11	...
Soya Bean Cake	††11 15 0	...	††11 0 0	...	††11 0 0	...
Decorticated Cotton Cake ...	...	...	13 15 0	...	13 15 0	...
Undecorticated Cotton Cake—						
Bombay (Home-manufactured)	7 15 0	7 5 0	7 6 6	6 18 0	7 3 9	7 0 0
Egyptian (Home-manufactured)	9 0 8	...	8 11 6	...	8 8 9	...
Coconut Cake ...	9 15 0	...	9 18 9	...	10 12 6	...
Palmnut K'nel Cake	...	...	8 8 9	...	8 7 6	...
Groundnut Cake— Undecorticated ...	*9 5 0	...	*9 9 0	**8 15 0	*9 5 0	**8 15 0
Maize Germ Cake—						
Home	11 0 0	...	10 18 0	...	10 11 3	...
Foreign ...	...	...	10 17 6	...	10 13 2	...
Maize Germ Cake Meal	11 15 0	...	11 6 0	...	10 13 9	...
Bean Meal ...	12 0 0	11 15 0	§12 10 0	11 15 0	§12 6 3	11 15 0
Maize Meal ...	11 8 9	11 10 0	10 19 0	11 10 0	11 11 3	11 10 0
Rice Meal... ...	7 10 0	...	7 10 0	...	...	...
Locust Bean Meal	...	7 10 0	8 2 6	7 15 0	8 5 0	7 18 9
Locust Beans (Kibbled & Stoned)	...	6 10 0	...	7 0 0	...	7 0 0
Maize Gluten Feed (Paisley)	9 15 0	...	9 15 0	...	9 15 0	...
Maize	‡10 15 0	10 15 0	‡10 11 0	10 7 6	‡10 14 5	10 7 6
Oats, Canadian ...	9 13 2	...	9 2 6	...	...	...
„ „ (No. 2 Feeds)	...	...	...	...	9 10 0	...
„ „ (No 3 Western)	...	...	...	...	9 2 6	...
„ Plate ...	...	...	...	...	7 16 11	...
„ Home ...	10 15 0	9 0 0	10 10 0	9 0 0	11 0 0	9 0 0
Barley (Feeding) ...	10 5 8	10 0 0	10 9 0	10 0 0	11 0 0	10 0 0
Malt Culms ...	7 5 0	...	7 1 0	...	6 16 3	...
Distillery Mixed Grains—Dried ...	8 17 6	8 10 0	...	8 10 0	8 6 8	8 10 0
„ Wet ...	...	1 15 0	...	1 15 0	...	1 15 0
Brewers' Grains—						
Dried	...	7 5 0	...	7 5 0	...	7 5 0
Wet	...	1 12 6	...	1 12 6	...	1 12 6
Distillery Malt Grains—Dried ...	8 9 5	...	8 10 0	...	8 0 0	...
Wheat—						
Middlings (Fine Thirds or Parings)	10 0 0	9 10 0	9 5 0	9 10 0	8 19 5	8 11 3
Sharps (Common Thirds)	8 15 8	8 10 0	8 5 0	8 10 0	7 16 11	8 0 0
Bran (Medium) ...	8 15 0	8 0 0	8 9 0	8 5 0	8 4 5	7 17 6
„ (Broad) ...	9 0 0	8 15 0	8 13 6	9 0 0	8 9 5	8 10 0
Feeding Treacle ...	8 10 0	8 10 0	8 0 0	8 10 0	8 3 9	8 12 6
Crushed Linseed ...	...	...	25 4 0	...	24 15 0	...
Fish Meal... ...	...	...	20 2 0	...	18 8 4	...

* Oil and Albuminoids 40 to 42 per cent. ** Oil and Albuminoids 37 per cent. § Pure China Beans.
†† F.o.r. Greenock. ‡ American.

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RECENT INNOVATIONS IN FARM MACHINERY.

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Rotary Tillage.—The conventional method of preparing a seed-bed for farm crops is first to plough the land and then to work the furrow slices down with tine implements until the soil has been cleaned of weeds and reduced to a tolerably uniform and fine tilth. In this series of operations the weather may either help or hinder: frequently in spring workings the up-turned soil dries so rapidly that clods form, which defy the powers of the farmer's ordinary equipment to reduce them until after a further period of weathering; and on strong soils in dry localities the tilth ultimately secured is often harsh, dry, and very unfavourable to the germination of small seeds. On many types of land the farmer's entire outfit generally fails to produce a seed-bed equal to that obtained by the gardener with his simple spade and rake; but neither the farmer nor the gardener can quite imitate the work of the mole, which even in a grass-field on soil of forbidding texture throws up its little mounds of beautifully fine and free mould.

Various attempts have been made to devise machines which would produce a fine tilth in one operation. The successful application of the principle known in Britain as rotary tillage, and on the Continent as fraizer work, is attributable to a Budapest engineer, Mechwart. The principle was popularised and exploited first in Germany by the firm Lanz of Mannheim, whose 60 h.p. Landbaumotor fitted with a soil fraizer has been widely adopted in that country for the work of breaking up moor and heath land in course of reclamation. The machine whereby the rotary tiller principle has been brought to the notice of British farmers, however, is the Simar, made in Switzerland. With the general construction of the Simar Rototiller most farmers who have visited an important agricultural show in recent years are doubtless familiar. Recently the Simar Society has introduced a rotary tilling attachment for existing tractors.

The motor-fraizer has certain mechanical advantages over the tractor hauling a plough or other implement. In the case of the tractor, haulage power is dependent on sufficient weight and suitable wheel strakes, while soft ground or a steep gradient may

so hamper the tractor as to render it inoperative. In the motor-fraizer, however, the tines of the miller exert a forward propelling force and thus relieve the travelling wheels of haulage duty. The machine can, therefore, be made of light weight; the wheels do not sink deeply into soft ground or pan the soil; and it climbs well. The debateable question concerning this machine, however, is whether the work it performs is good husbandry.

Unfortunately the rotary tiller was not brought to the notice of British farmers when they generally had sufficient interest and money to buy equipment for mechanical tillage. There is accordingly not a great fund of experience upon which to draw. Several users known to the writer possess the smaller machine, and all speak in high terms of its utility and of the excellence of rotary tillage work. Their principal criticism concerns the liability to break tines when working in stony ground. In the Highland Society's trials at Dalkeith in 1922 the Simar Rototiller was subjected to three tests, on which the Reporting Committee made the observations quoted hereunder:—

1. On a piece of unbroken stubble: the machine was found "to pulverise the soil thoroughly to a depth of 8 inches, leaving a fine loose mould 10 inches deep."
2. On a piece of dirty ground working to a depth not exceeding 5 inches: it was found that "the wrack and surface weeds were effectively thrown out and left clean and on the surface." Hence the Committee considered it "an exceptionally useful implement for autumn cleaning of dirty land."
3. On lea: "owing to the fact that much of the turf was broken up and left on the surface, it was considered to be quite unsuitable for this class of work."

For spring cultivations the rotary tiller is undoubtedly a machine to be desired. Provided the soil is in fit condition for refinement, the machine extracts weeds and produces an ideal seed bed in one operation, thereby saving valuable time, labour and moisture. The difficulties of growing root crops on heavy soils are considerably reduced by the use of the rotary tiller in the spring workings. For autumn tillage, however, this machine is of only limited service, viz., in cleaning dirty stubbles during a dry September. For general autumn working there are objections to refinement of the soil: wheat does not winter well on such a seed bed, which is apt to hold too much moisture and to become crusted or capped; and land intended for roots comes earlier into condition for spring workings and works down better to a friable mould when the autumn or winter ploughing has left the furrow intact rather than pulverised.

Most farmers, especially those in wheat-growing districts, can make best use of mechanical tillage equipment in the autumn working of corn and clover stubbles; for these purposes the tractor plough is superior to the rotary machine. For spring work, however, tractor ploughs and implements are not so much appreciated. There is room, therefore, for the rotary machine which can be fitted to existing tractors; if the attachment is

successful it will displace tractor cultivators and disc harrows and increase the usefulness of the tractor in soil management.

The Rein Drive Tractor.—Another innovation, which like the rotary tiller has appeared at a time when interest in mechanical cultivation is less keen, is the almost uncanny rein driven tractor. This its makers, Messrs. Fowler of Leeds, state has been developed in Australia. It is a two-wheeled tractor which is rigidly coupled to the implement, machine or vehicle that it is required to haul; and the operator, riding on the implement, drives the tractor with a pair of reins as if it were a horse. By the simple operation of the reins with one hand the motor is caused to advance, back, stop, wheel to right or left without going forward, or to turn round in a small space. Its power steerage device makes it very handy for manœuvring in confined places; and, it is claimed, square corners can be cut with a binder hauled by this tractor just as easily as with horses. The arrangements for ensuring wheel adhesion with the minimum of soil compression are also interesting.

One great consideration in favour of driving the tractor from the seat of the working implement, is that the driver is thereby removed from the vibration, noise and other discomforts which have alienated so many farm-men from the ordinary tractor. Another advantage of this arrangement is that, in operations now recognised to be one-man jobs, the driver has the working implement before him and therefore in sight. Doubtless, this advantage, together with the fact that the tractor is controlled by one hand, will extend the use of this source of power to such operations as drilling, mowing and reaping under favourable conditions, since one man can operate the combination as in team work.

The main idea in the design of this tractor appears to have been that of evolving a machine which shall behave as nearly as possible like the horse. It does readily and correctly respond to the reins; but naturally it lacks that "horse-sense" which enables a team to learn where to walk and to obey the voice. This tractor is, however, the nearest approach to the mechanical horse that has ever been placed before the British farmer.

Subsoilers.—Several makers have brought out two-furrow tractor-ploughs in which the front body may be replaced by a single tine capable of subsoiling to a depth of 5 inches below the bottom of the furrow last opened out. There are now also special deep-digging ploughs with a subsoil-tine fixed behind the mould board. Another device is that of attaching the subsoiling tine to the tractor itself.

The question of the usefulness of the above appliances turns upon problems other than those which engineers have more or less solved. The devices all do good work so far as stirring a track in the subsoil is concerned; but the operation of subsoiling is not invariably beneficial and, in fact, the number of cases where it has produced appreciable improvement in fertility is not large. In the Essex trials, 1923, subsoiling was reported to have increased the yields of potatoes by 20 to 50 per cent. in the first crop after the operation; but in this case the comparison was made between plots ploughed only 5 inches deep and plots subsoiled below that depth of furrow. An experiment based on this depth of ploughing

for potatoes does not afford evidence which would convince a north country farmer of the value of subsoiling as an addition to ordinary deep cultivations. The Rothamsted trials, which have extended over 10 years, do not show very striking results in favour of subsoiling, although they do point to a slight advantage.

Further experimental work and research on the soil questions involved in this subject are required; but it may well be found that subsoiling can add little to the fertility of land that once or twice in the rotation is ploughed deeply and is further deeply stirred between the rows of potatoes or root-crops cultivated on the ridge system.

Grassland Rejuvenators.—Nearly a century ago implements for stirring the surface of grass land were designed and made; but since artificial manures were introduced, the effects of which on clean bottomed grass land are usually very pronounced, less attention has been paid to the possibilities of stimulation by tillage operations. In arable cultivation it is recognised that tillage promotes the liberation of plant food locked up in the soil; but in the case of grassland it is possible for food reserves to accumulate, while the pasture or meadow at the same time deteriorates in productivity.

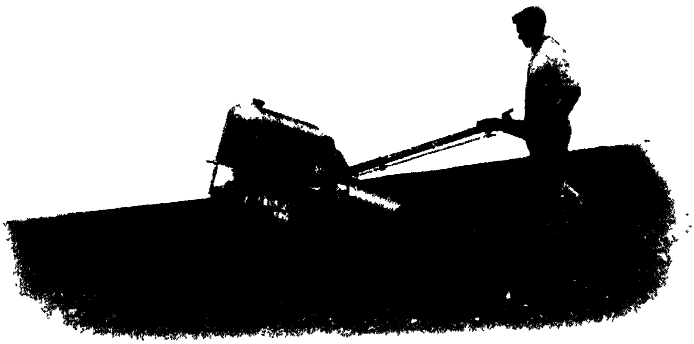
This subject has had most attention on the Continent. In France the common grubber is converted into a "Regenerateur de Prairies" by substituting knife coulters for the usual tines; in Germany a special implement is made which not only cuts grooves in the turf, but also throws up soil to be spread on the surface by harrowing. This implement commends itself on the grounds not only of aeration, but also of the well known beneficial effect produced by spreading soil on the surface of rough pastures.

During the past two years Messrs. Howard and Messrs. Ransomes have each introduced turf slitters; the latter has knife coulters, the former both knives and discs; neither, however, embodies the feature above mentioned in connection with the German implement.

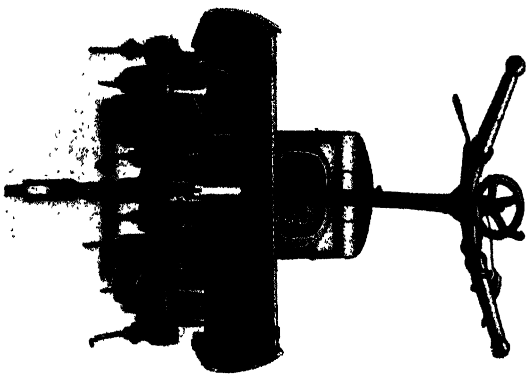
Surface Sowing Coulters.—It is well known to farmers that a corn seedling on being pulled up is usually found to have a thin white shoot 1 to 2 inches long between the seed at the lower end and the node from which the main roots issue near the soil surface. Advocates of surface sowing argue that, since the plant ultimately forms its roots near the surface of the soil, the production of the said white shoot entails waste of time and seed substance and meanwhile exposes the seedling to wireworm attack. The shallow-drilled seed, they urge, establishes itself more quickly and tillers better, and consequently this method allows of economy in quantity of seed.

The vigour of braird shown by shed corn can hardly be fairly quoted in favour of surface sowing; here it is the best, most mature corn that falls on the ground; the "sowing" is early, and the seed bed is firm.

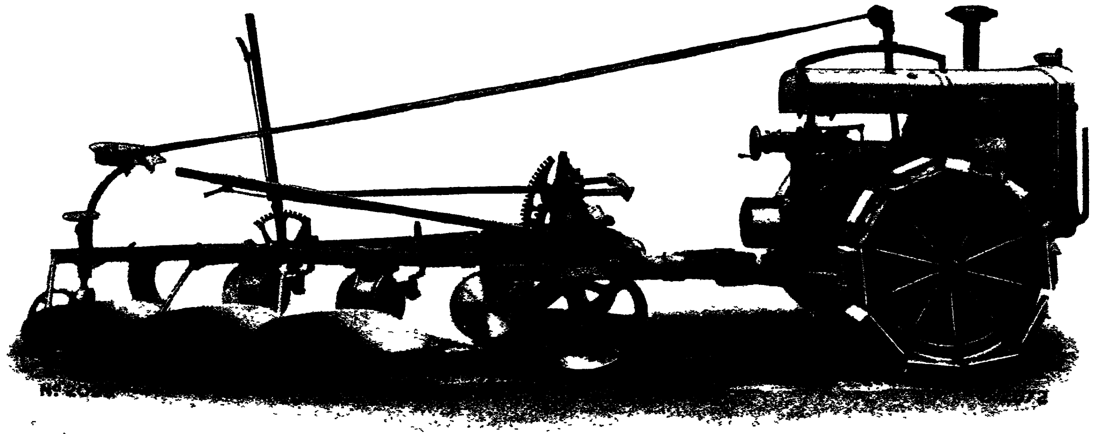
The special coulters offered for shallow drilling are also designed to spread the seed over a width of about 3 inches instead of confining it to a narrow band. On this point the advantage may be admitted, unless the crop is to be horse-hoed; but drills with



ROTOTILLER AT WORK.
(See page 357.)



REAR VIEW OF THE ROTOTILLER WITH MILLER COVER REMOVED.



REIN DRIVE TRACTOR.

(See page 359.)

coulters only about 6 inches apart do not cluster the seedlings upon each other so much as those with interspaces of 8 inches or 9 inches, and in the case of oats which are seeded at heavy rates, double (cross) drilling further mitigates the evil.

The principal objects in covering seed are to hide it from birds and to place it within reach of sub-surface moisture—to ensure continuous germination. In late autumn or early spring sowing there is generally more than sufficient moisture; but birds, having at those times less natural food available, are unusually troublesome. In these cases there is a tendency to drill too deeply, so that the seed often perishes from lack of air; the seedling may be unduly long in establishing itself, or die from exhaustion of the food reserves in the seed; or it may be "thrown out" by the frost, if this comes just when the blade has appeared but the seedling has not yet formed its crown roots. Shallow ($1-1\frac{1}{2}$ inches deep) sowing of corn may be preferred for work between the end of October and the end of February.

Deep ($2\frac{1}{2}$ inches $-$ 3 inches) sowing of corn is desirable when in early autumn or late spring the seed bed is rather loose. Such a seed bed is apt to settle down upon itself; and, if the seed has been sown shallow and the seedling has made rapid growth, its crown roots may later be left exposed, giving the "root fallen" appearance. Another occasion for deep sowing occurs when drilling spring corn on land known to be infested with charlock. If in this case the seed is put in deeply and the land rolled, the charlock will germinate and may be destroyed by light harrowing before the corn is through the ground.

A good drill coulter will place and cover the seed at either of the depths above mentioned, if the tilth is suitable; hence there hardly appears to be a real need for special devices for surface sowing only.

Silage Cutters and Blowers.—The coming of the tower silo, which is steadily extending its distribution in all parts of the country, has created the need for machinery with which to chaff the green fodder and elevate it to the top of the silo. Until recently, British manufacturers had not offered such machinery, although the problem they had to solve was nothing more than that of equipping an ordinary large fodder-chopper with a fan of sufficient power to deal with heavy green material. The machine used for filling most of the silos in this country, therefore, is of Canadian manufacture, and is in fact the same machine as was formerly described as a straw cutter and blower. In this the blowing device consists of four fan blades, bolted to the same heavy fly wheel as carries the two chopping knives, but projecting beyond its periphery and just clearing the case which encloses the whole. Provided that a machine of sufficient capacity be installed, and provided again that it be driven at the proper speed—800 to 1000 r.p.m.—the blower will elevate the cut green fodder to the top of an ordinary silo without much trouble from a choked blower-pipe.

Mounting the chopping and blowing devices on the same fly-wheel in the above manner embodies certain disadvantages:—1. The machine must be driven at a speed sufficient to blow the green chaff, viz. 1000 r.p.m., although the best speed for chopping

is only about 250 r.p.m. 2. If the chopper lags or chokes, the blast diminishes or stops, and this may involve a choke in the blower pipe. 3. There is a loss in accessibility; in particular the knives cannot be whetted while in position, as they can on an ordinary chopper. In Messrs. Bentall's silo filler the blower and chaff-cutter spindles are separate and revolve at different speeds, viz. 900-1200 and 250 r.p.m. respectively. This machine has also a special drive which ensures maintenance of the blast even if the chopper is choked or stopped. The chaff cutter is one of the firm's well known three-knife hay choppers, hence the machine may also be used for the purpose of chaffing hay and straw.

Artificial Drying.—In some districts the curing of grass and corn crops is almost invariably a protracted process, and in every district in one season or another wet weather at the time of hay or corn harvest causes great and expensive hindrance and depreciates the value of the crops. Attempts to devise means of harvesting without the aid of good weather are therefore of unusual interest, and if ultimately a method is found whereby better fodder can be secured at a less cost than air-drying entails in a catchy season, farmers in general will adopt and appreciate the boon.

The idea of drying stacks by means of a current of air is not entirely new. Even more than 40 years ago the R.A.S.E. instituted trials of plant for drawing air through hay ricks. Probably the unhappy result of these trials — spontaneous combustion — discouraged further interest in this line of investigation for a considerable time. During the past three years, however, wide publicity has been given to a modified method, in which the air is forced from the inside of the stack outwards. The fodder is stacked with a small framework in the middle, which forms a central chamber; into this air is forced by means of an engine-driven fan and permeates the mass, making its escape at the outside of the stack.

In spite of the successes claimed for this method, artificial drying is as yet only in the experimental stage. Merely blowing air through a heap of damp fodder does not necessarily dry it: the air may be—in bad weather it often is—nearly saturated, and therefore incapable of taking up any moisture from the fodder. If the fodder is colder than the air that is being blown through it, dew is deposited in the stack. If on the other hand the fodder is warm, so that the air entering it is caused to absorb more moisture, this extra moisture is apt to be deposited again as the current of air reaches the cooler outer regions of the mass. In material such as grass, which goes together into a comparatively compact mass, there is the additional difficulty of causing the air to permeate uniformly a reasonably large stack.

The Ministry of Agriculture in 1923 made observations on twenty-one stacks of various crops subjected to the above treatment and found that while corn, bean and pea stacks were treated successfully, the same could not be said of hay. The product was always more or less mouldy. A Derbyshire farmer has tried the same process during the last two seasons; but in each case the result has been mouldy hay, except in the centre of the stack just round the air chamber.

Dairy Appliances.—The growing interest in the production of milk with a low bacterial count has created a demand for better and additional equipment in the farm dairy. The ordinary milk cooler or "refrigerator" is not so efficient as it might be; it exposes the milk unduly to the atmosphere, which, if not necessarily a source of contamination, prevents the cooling water from sufficiently reducing the temperature of the milk at times when thorough cooling is most necessary. In hot weather the film of milk passing down the cooler may have water at 50° F. on one side, but on the other it is in contact with air at perhaps 65° F. This defect has been overcome by enclosing the cooler in a detachable metal cover, or by causing the milk to flow in two streams over flutings that face inwards. In view of the difficulty in certain districts of obtaining really cold water for cooling purposes, however, there is room for farm apparatus (at a price within the farmer's means) for the artificial production of cold.

The necessity for steaming dairying utensils has been repeatedly proved. Without the aid of steam, the introduction of covered pails, for instance, may actually result in an increased bacterial count. The farmer can make a simple but inconvenient steaming outfit by adapting the washhouse copper, or he may use an oil stove and a large pan, a steam duct being provided in each case. But what is really needed is a small steam generator heated by means of oil burners, capable of rapidly producing and directing a jet of hot steam into a steaming chest. The provision of safety and perhaps injection and pressure indicating devices would be necessary, which complicates the problem; but such a piece of apparatus available at a suitable price would be a boon to many.

The requirements of the larger milk producer have recently been specially catered for by Messrs. Barford & Perkins in their "Cleena-Milk" sterilising outfit. This consists of a boiler (heated by a coal fire) connected by flexible rubber pipe to a sterilising chest, which is large enough to hold railway churns in addition to other dairy utensils.

Limestone Grinding Mills.—There is much land that would greatly benefit from liming; even in districts where limestone outcrops occur on every farm, the soil may be generally deficient in lime. The direct and incidental cost and inconvenience of applications of burnt lime, however, deter farmers from giving the land the treatment which it obviously requires. Ground limestone has been found to give much the same results as its equivalent in burnt lime, provided that the limestone be applied in the form of a fine powder. It would appear, therefore, that there is room for a machine that could be used by farmers in a limestone or chalk district for grinding their own rock.

There are several pulverising machines on the market, which the makers claim to be capable of reducing limestone rock to a fine powder. The larger machines appear to require an engine of about 25 to 28 B.H.P. to grind down 2½ to 3 tons of rock per hour. There are also smaller machines, requiring less than 15 B.H.P., to produce about 1 ton per hour; these could be driven by an ordinary farm tractor or steam engine. In view, however, of the general

lack of available experience regarding the performance of such machines as limestone grinders, it is desirable that public trials should be instituted.

NORTH AMERICAN EXPERIMENTAL FARMS.

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THE agricultural research of the United States is carried out mostly by the Federal Department of Agriculture and by the States Universities, Agricultural Colleges and Experiment Stations. The Department of Agriculture has its own farms and centres of investigation; it places members of its staff in State Experiment Stations, and it does much to further the co-ordination of national research by maintaining in its Bureaux a staff of technical experts who move from college to college and from State to State. These experts discuss problems under investigation, disseminate new ideas, and do much to prevent unnecessary duplication of work. The problems which are approached by the Federal investigators are usually of general scientific interest or practical importance, or they have a particular significance for a group of States, *e.g.*, the alkali soil problems of the semi-arid West and the control of boll-weevil in the cotton-belt. The staffs of the State Universities and Agricultural Colleges are as a rule part-time teachers, though in the more wealthy institutions the staff engaged solely on research work is a very considerable one, and they, along with the research workers in the State Experiment Stations, are engaged for most of their time on problems that have a distinct local importance, *e.g.*, the control of weeds in the rice crop in California; the maintenance of organic matter in the corn (maize) lands of Illinois; and the dry farming problems in Colorado.

Experimental work in Canada is carried out by (1) The Agricultural Colleges, (2) The Dominion Experimental Farms, and (3) The Provincial Experimental Farms. The Colleges do work corresponding to that which is done in the United States Universities, and they are run on similar lines. The Dominion Experimental Farms, which are scattered throughout the typical agricultural areas of the Provinces, have neither the technical staff nor the laboratory accommodation to carry out much research. They are used, however, for carrying out trials with a view to finding out the best varieties of crops for local conditions, the best system of crop rotation, and for the elucidation of other problems of a similar nature. These farms are generally stocked with first-class pedigree animals, and they not only demonstrate the capabilities of the breeds, but form centres from which farmers may purchase stock for grading-up purposes. Poultry husbandry is one of their strongest features, and they encourage local enterprise by conducting egg-laying trials. The more laborious problems are generally undertaken in conjunction with the Dominion Central Experimental Farm at Ottawa, where a large technical

staff is employed and where there are facilities for intricate work. The Provincial Farms work on a smaller scale; they carry first-class stock and grow the most approved varieties of crops: they are used more for demonstration than for experimental purposes.

The North American agricultural scientist is a specialist: he is a specialist in the narrowest sense of the word. As a student he must specialise in taking a degree in agriculture. If he chooses agronomy[1] as his main subject he will get little if any instruction in animal husbandry, and none whatever in subjects like dairying and forestry. In post graduate work he becomes even more specialised. The animal husbandry man may specialise not only in cattle but in beef cattle in particular. He may superintend the beef cattle on a college farm, but his business will never take him near the Holsteins or the Jerseys, and he never by any chance has a say in the management of the horses or the pigs. The agronomist may become an expert in maize, wheat, forage crops, etc., and should he develop into, say, a forage crop expert he may reasonably expect to receive an appointment where his whole time is occupied with the teaching of forage crop culture and the management of forage crop trials. He, of course, understands the hybridisation and selection of the various species in which he has specialised, and this forms part of his field work. As a consequence of the specialised training of the investigators, the large staffs, the fine equipment, and the large acreage of select land which is available for experiments, many of the Experiment Stations turn out as much work as half-a-dozen British research institutions.

THE COLLEGE FARM AND ITS MANAGEMENT.

A typical University Experimental Farm is divided into the following sections:—1. Agronomy; 2. Pomology; 3. Horticulture; 4. Dairying; 5. Animal Husbandry; 6. Forestry; 7. Poultry Husbandry; and 8. General farm land run by the Farm Superintendent.

The farm lands are divided according to the needs of the various departments, and, as funds are generally sufficient, such buildings as may be required for departmental purposes are erected where they may be required. The agronomy department has its grain stores, drying sheds, threshing and cleaning apparatus, and tool houses; the pomology department has its fruit stores and packing sheds; the horticultural department has glass houses, an irrigation system, potting and tool sheds; the dairying department has cattle barns, a tread-mill to exercise the bulls, silos and calf pens; the animal husbandry department has horse, sheep (sheep are mostly house fed during winter) and cattle barns; the foresters have their nurseries; the poultry department has runs, stores, an incubator house, etc. Needless to say each department has also its class rooms and laboratories for theoretical instruction and research, but these are usually on the University campus and not on the farm. Some departments, *e.g.* agricultural engineering and soil physics, do not possess their own part of the farm, but never-

[1] Agronomy combines the sciences of Field Husbandry and Agricultural Botany, including Plant Breeding.

theless carry out useful laboratory investigations, and do field work on the farm lands which are not allocated to any particular purpose.

The nominal head of the farm is as a rule the Professor of Farm Management. Where the farm is largely cut up and set aside for the use of various departments, the senior professor in each department is in charge of his section, and although he may nominally be answerable to the Professor of Farm Management he has really a perfectly free hand to plan and carry out his own work. The departmental chief in turn allocates the duties to his specialist staff, who deal directly with the working foremen. For example, the senior professor of animal husbandry will be in charge of all the stock of the farm except the poultry, certain work horses, and, in some cases, the dairy cattle. Where the cows are not managed by the animal husbandry department they come directly under the control of the milk production side of the department of dairying. The head of the department of animal husbandry will allocate the control of the swine, sheep, etc. to his junior professors or lecturers who have specialised in the respective species.

The Farm Superintendent corresponds to a farm manager on a British college farm. He is usually a graduate in agriculture with specialised knowledge of farm management, and one who is intimately acquainted with practical agriculture. His business is to look after the ordinary farm lands, horses and labour; he grows the corn, hay and silage which are necessary for the support of the live stock, his crop acreages being determined according to the number of animals it is proposed to keep.

The following is a tabular representation of the management of farm affairs :—

<table>
<tr><td rowspan="7">Professor of Farm Management.</td><td>Professor of Milk Production—Herdsman—Dairy Cattle.</td></tr>
<tr><td>Professor of Animal Husbandry—
Lecturer on Swine—Herdsman—Swine.
Lecturer on Sheep—Shepherd—Sheep.
Lecturer on Beef Cattle—Herdsman—Beef Cattle.
Lecturer on Horse Management—Stud Groom—Breeding Horses.</td></tr>
<tr><td>Professor of Agronomy—Foreman—Labour and work horses for experimental land.</td></tr>
<tr><td>Professor of Horticulture—Foreman—Gardeners, etc.</td></tr>
<tr><td>Professor of Pomology—Foreman—Orchard workers, etc.</td></tr>
<tr><td>Farm Superintendent — Work horses, general labour and management of land not allocated to special departments.</td></tr>
</table>

The heads of the departments prepare estimates of such expenditure as will be necessary for the purchase of stock, etc. When the estimates have been approved they go ahead and make their own purchases, going to whatever they consider to be their best market, *e.g.*, in 1923 the Professor of Horse Management in the University of Illinois went to France to purchase a Percheron stallion because he could not get in the home market the type of horse that he required. Small purchases and sales of surplus stock and crops are either transacted by the department which is concerned, or arranged through the Professor of Farm Management and the College Bursar.

Methods of Conducting Field Trials.

A. *Cereal Trials at Ontario Agricultural College, Guelph.*[1]

The experimental ground is divided into four portions and is regularly put through the following rotation :—1. Roots and Maize (dunged); 2. Wheat; 3. Spring cereals; and 4. a mixture of Oats and Sweet Clover which is grazed. An obvious fault in this system is that grazing will cause irregularities in the soil which will influence subsequent crops. Experience has shown, however, that it is only by this kind of management that the productiveness of the soil can be indefinitely maintained. For trial purposes the land is divided into suitable areas by means of temporary roads, which are kept free from weeds throughout the growing season.

The ground intended for yield trials is marked off into strips 100 links wide, the strips being separated by temporary roads $12\frac{1}{2}$ links wide (see Fig. I.).

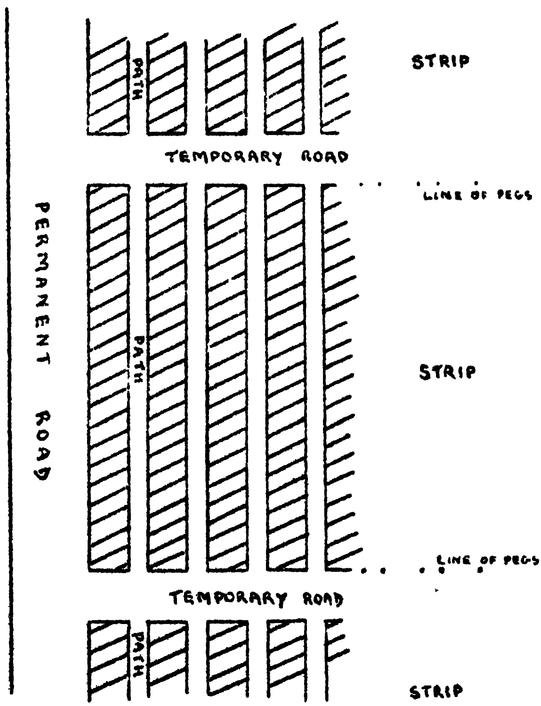

FIG. I.—Arrangement of Plots on Guelph Trial Grounds.
The Plots are shaded.

The next operation is to divide each strip into a series of $\frac{1}{100}$ acre plots, the length of each plot being 100 links (the width of the strip) and its breadth 10 links. The plots are separated by 5-link paths. Marking is done with white painted wooden pegs 2 feet

[1] The area devoted to hybridization and plant selection at Guelph is greater than that used for similar work at any other institution in North America; moreover the results have been particularly satisfactory, Ontario Agricultural College Oats, Barleys, Peas and Soy Beans being the most widely cultivated varieties throughout the Province.

long and of 2-inch square section. These are driven so that 4 inches remain above the ground. In this way the pegs marking the ends of the plots form rows running along the sides of the strips. A special device is employed whereby the pegs can be accurately and expeditiously placed and at the same time perfectly aligned. This device (see Fig II.) consists of a long wooden plank pierced by square holes which are just large enough to allow a standard peg to pass through. The spacing of the holes is made to correspond with the widths of the plots and paths, and the plank is strengthened at the holes by means of iron plates. The device is used as follows:—A peg is driven in at the corner of the strip where it will also mark the corner of the first plot. A theodolite is set up and sighted over this peg and along the proposed line. The marking plank is then laid down with its notched end against this first peg; it is aligned by means of the theodolite, and pegs are driven into the ground through the holes, being in this way both accurately placed and squarely set. The plank is then lifted and moved to the next position, aligned, and the next pegs are driven in. This process is continued until the line is finished, and the pegs at the other ends of the plots are then set out in the same way.

To overcome the difficulties involved in removing a large number of pegs at the end of the season, the peg extracting tool illustrated in Fig II. is employed. This device will quickly remove a long peg from the hardest of soil, and its use prevents the loss through breakages which takes place when pegs are loosened by means of a mallet and withdrawn by hand.

The method of sowing the cereals is to broadcast the seed and harrow it in. A special spring-tined harrow has been devised which allows the horse to walk on the paths and which has its tines so shaped that they do not catch on the pegs. As far as the replication of plots is concerned, it is seldom that a variety is sown more frequently than in triplicate.

When ready for harvesting, the cereals are cut with a scythe which has a cradle attachment, then bound and stooked on the plots where they have grown. As soon as they are ready they are carted and threshed. It is in the certainty of being able to thresh out of the stook that the North American investigators have the greatest advantage over field-trial workers in this country. Over the whole of the States and the greater part of Canada cereal harvest takes place at a very hot time of the year and long before the earliest possible winter can interfere with drying operations. Consequently it is only where a tremendous number of small plots have to be handled with limited threshing appliances that there is any need to find storage accommodation for the crop.

The produce is carried in a specially constructed wagon from the field to the threshing barn. This wagon differs from the ordinary American type in being divided into two compartments which are lined with sheet metal so that there are no crevices in which seeds may lodge. The crop is carried at the rate of one plot per compartment, the label or number of the variety being carried at the same time, thus assuring identification when it comes to threshing.

FIG. II.—Plot Marker and Peg Extractor used at the Guelph Station.

FIG. III.—Rod-row sheaves bound in cotton fabric for protection.

Fig. V.—Weighing forage crops at the Minnesota Station.

The threshing barn is in two storeys, and has an elevated wagon-way leading to the level of the upper floor. The produce is forked from the wagon on to a metal-covered weighing platform situated opposite the door of the upper compartment. This platform is constructed like an ordinary weigh-bridge and enables the total weight of the crop from each plot to be ascertained at this stage. Even the few scattered grains obtained in cleaning out the wagon compartment are added to the pile before the weight is recorded. A metal chute leads from this floor to the lower storey where the threshing machine is fixed. Carrying, weight-recording, threshing and bagging go on simultaneously. The material, as soon as it is weighed, is passed down the chute to the thresher, great care being taken to sweep the metal platform perfectly clear. The next batch is then dealt with. The type of thresher employed is by no means a small machine, being in fact considerably larger than many of the small farm threshers used in the north of Scotland. The construction, however, admits of quick cleaning when changing from one variety to another, and to this end it is fitted with a minimum number of riddles. As a consequence of this the grain is not thoroughly cleaned, and although it is bagged it must afterwards be put through winnowing and dressing machines to free it from weed seeds and other impurities. This part of the work, except in the case of winter wheat which is destined for sowing the same year, can of course be done later in the season when the pressure of field operations is over. The yield data are not obtained until the final cleaning has taken place.

Selecting New Varieties.—Commercial crops throughout the Province are examined for promising ears in order to get a large variety of plants from which to make selections. These are collected at the College, threshed, and the seed sown on the trial grounds. Even more of this selection work is done, however, by planting seeds of different commercial varieties—which contain occasional sports or natural hybrids of superior merit—in such a fashion that close observations can be made on the growth and development of the individual plants. To do this individual kernels are planted 6 inches apart each way, the method of planting and the subsequent management being as follows:—The land is drawn into shallow drills, 6 inches apart, by means of a rake-like implement fitted with suitable tines. A small depression is then made for each seed in the bottom of the furrow by means of a special tool. This consists of a V-sectioned wooden beam provided, for convenience in moving, with vertical handles at the ends. Iron knobs about the size of marbles are screwed into the bottom of the beam at 6 inch intervals throughout its entire length. Thus when the V of the beam is pressed into the shallow furrow the knobs make cup-like depressions in the furrow bottom, and in these depressions the individual seeds may be placed. Sowing and covering are of course done by hand.

When the plants are a few inches high the ground is gone over very carefully and pegs are put in wherever a plant has failed to grow. The object of doing this is to be able to avoid selecting plants which have grown next the bare places, as the

increased nutrition at these points tends to give the plants an unmerited appearance of superiority. The trial plants are kept under observation throughout the growing season, and the best of them—amounting to a very small fraction of the whole—are tagged and harvested when ripe, the remainder being discarded. Plants of outstanding merit found in this way, or selected by the first method from commercial crops, are threshed and the seed is sown in a row at regular intervals, the shallow furrow and beam-marker being again employed. In the following year the best three plants of this row are sown respectively in three rows (or three double rows) which are marked A, B and C, and the best three plants of the best row are harvested and retained, the remaining plants of that row and the whole of the other two rows being discarded. These three plants are again sown in three rows and the process is repeated until a pure line has been established. A variety obtained in this way is grown on increase plots until there is a sufficient quantity of seed to enable it to be tried against standard varieties. If it turns out that it possesses definite superiority or usefulness it will be grown on large increase plots and sent out to the farmers of the Province; if it is no better than other sorts in general cultivation it is discarded. The progeny of artificial hybridization goes through this same process of selection.

B. *The Rod-row Method of Cereal Trials.*

This is simply a means of testing varieties in single short rows instead of by means of plots. It is within the last few years that the rod-row system has been developed, and the chief reason for its very wide adoption is because it allows of the accurate testing of a very large number of varieties on a moderate area and with a minimum of labour. The objection to the use of plots for a large number of varieties lies in the almost insuperable difficulty of getting a really large acreage of uniform land. Plots have also correspondingly greater labour, seed and storage requirements. The name "rod-row" implies a row of definite length, but it should be understood that this is by no means the case, the rows in actual practice being made from under 12 to over 20 feet according to the ideas of the investigator and the area of ground that is available. Usually the length is adjusted so that when the rows are 1 ft. apart a simple factor may be used to obtain the yield per acre. Thus at the Cornell Station the oat rows are 15 ft. long and the yield in grams per row is multiplied by ·2 to convert it into bushels per acre.

There are a number of ways of setting out the rows and sowing the seed. The whole of the area on which the rows are to be grown may be worked into a suitable tilth and then drawn into shallow furrows, 1 ft. apart, by means of light ploughs. Series of rows can then be marked off, along with the dividing paths, by running strings across the field at right angles to the furrows. The paths are afterwards raked level. The land having been got ready for sowing in this way, the foreman is given (1) a plan showing the sequence of the varieties throughout each series, (2) the packets of seed which have been weighed up in the laboratory

according to the standard rates of seeding, and which have been arranged in the order of sowing, and (3) the labelled pegs[1] for insertion at the ends of the rows. In order to get a basis for comparison and to reduce the experimental error to a minimum, every 10th row throughout the series is a check row of the same standard variety, and the varieties under test are replicated ten[2] times. If there are 90 varieties under test they, along with the check rows, will occupy 1000 rows. The variety which is grown in, say, the 27th row will be grown again in the 127th, 227th and so on up to the 927th row of the series. Sowing is done by hand and the seed is covered by means of a hoe. The rows are all made a foot or two longer than they are required so that the outside plants, which have the advantage of growing next the bare paths, may be discarded. The first and last rows of the series are discarded for the same reason.

A modification of the above method is to set out the paths first and then to open the furrows by means of a hand implement. Yet another method is to sow the rows by means of a drill which is specially designed for quick and thorough cleaning.

A difficulty with rod-row trials arises as a consequence of different habits of growth and earliness of adjacent varieties. Thus a short strawed variety which is sandwiched between two tall growing sorts may be subjected to a smothering which seriously affects its yield. Again an early ripening variety between two late sorts is likely to lose grain through shelling before it can be conveniently harvested. To obviate these difficulties as far as possible, the varieties are arranged so that those of similar habit of growth and earliness are grouped together. At some stations, however—*e.g.*, California—the varieties are grown in groups of three rows. At harvest the outside rows are discarded and the centre one only is taken for threshing and yield estimation. Some of the trial work at the Illinois station is done by sowing four rows of each variety together, but this procedure is virtually the same as using long narrow plots with no intermediate paths.

When the crop is ready for harvesting, wires are stretched along the ends of the rows to cut off the plants which are outside the calculated area and must therefore be discarded. Another method of doing this is to use a plank cut to the exact length of the row required. This is laid down as a measuring rod by the harvester, who can then cut the correct length of row. Harvesting is done by three men. Two cut with hooks and take very great care to keep all the ears well bunched together at one end of the sheaf (this is very important because of the method of threshing). The third operator ties up the sheaf and encloses the marking peg from the end of the row. Where no marking pegs are employed he attaches a label bearing the number of the row. Tying is done by means of soft wire, which can be twisted round the sheaf much more quickly than a string could be knotted.

[1] Where thousands of rows are grown, an economy in pegs may be effected by numbering every 10th row only. In this case sowing takes place according to a key plan and a row is known only by its number until such time as the plan is again consulted for the analysis of the threshing results.

[2] For less important work varieties may be grown in triplicate or quadruplicate only.

The next part of the work is to get the little sheaves properly dried without exposing them to the attacks of birds[1] or running the risk of the grain shelling. One method is to take the sheaves straight to a vermin-proof drying shed and to hang them upside down from spars so that they are exposed to a good circulation of air. Another plan is to wrap the head of each sheaf in pervious cotton material which, while it keeps off birds and prevents loss through shelling, allows of sufficient æration to insure drying (see Fig. III.). When dry, the sheaves which are thus protected can be stored in almost any fashion without fear of the seed mixing.

As soon as the sheaves are dry, threshing may commence. Owing to the thousands of rows that have to be handled at all the large stations it is absolutely essential to obtain a thresher which is effective and at the same time rapid in its action; moreover it must require little or no cleaning after each variety is put through. Few machines are perfect in this last respect, but there are many in which cleaning is reduced to a minimum. The simplest form of thresher for this purpose consists of a small drum and concave mounted over a removable hopper. Threshing with such a machine takes place as follows:—The operator unties a sheaf and hands the peg or label to his assistant, who does the bagging. He then puts the *head* of the sheaf between the revolving drum and the concave but *holds on* to the butt and the greater part of the straw. The drum threshes out the grain and breaks up the straw of the ear so that grain, short cavings and chaff fall down into the hopper. The operator then throws the butt behind him and goes for another sheaf. Meanwhile the assistant takes out the full hopper and puts in an empty one; he then blows the chaff and cavings out of the first hopper with an ordinary pair of bellows and empties the grain into a bag which he labels and closes.

On page 373, Fig. IV., is a sketch of the best type of row thresher seen by the writer. It was at the Minnesota Station.

Method of Operation.—The head of the sheaf is threshed between the drum and the concave; the butt is withdrawn and discarded. The grain, chaff, etc. fall down and are caught in the draught which issues from the main orifice of the blower, D. This draught carries the light chaff right over the end of the polished tin chute, E; but the grain being heavier, strikes on the chute and slides downwards into the removable hopper, F. The angle of the chute and the strength of the draught may be adjusted to suit different kinds of grain.

The wind-dressing apparatus attached to the side of the machine is then used to clean the grain further. A bag is attached to the funnel, I. The contents of the removable hopper are poured into the fixed hopper, G, the screw, J, being adjusted to allow the material to flow gently out of the hopper and through the strong current of air which issued from the blower nozzle, H. The heavy grain passes through the draught, being caught in the funnel, I, and led into the bag. The lighter chaffy material, however, is

[1] Damage to plots by birds is much less serious in North America than in this country, chiefly, it would appear, because the very long and hard winter and the consequent scarcity of food prevents the birds from becoming over numerous.

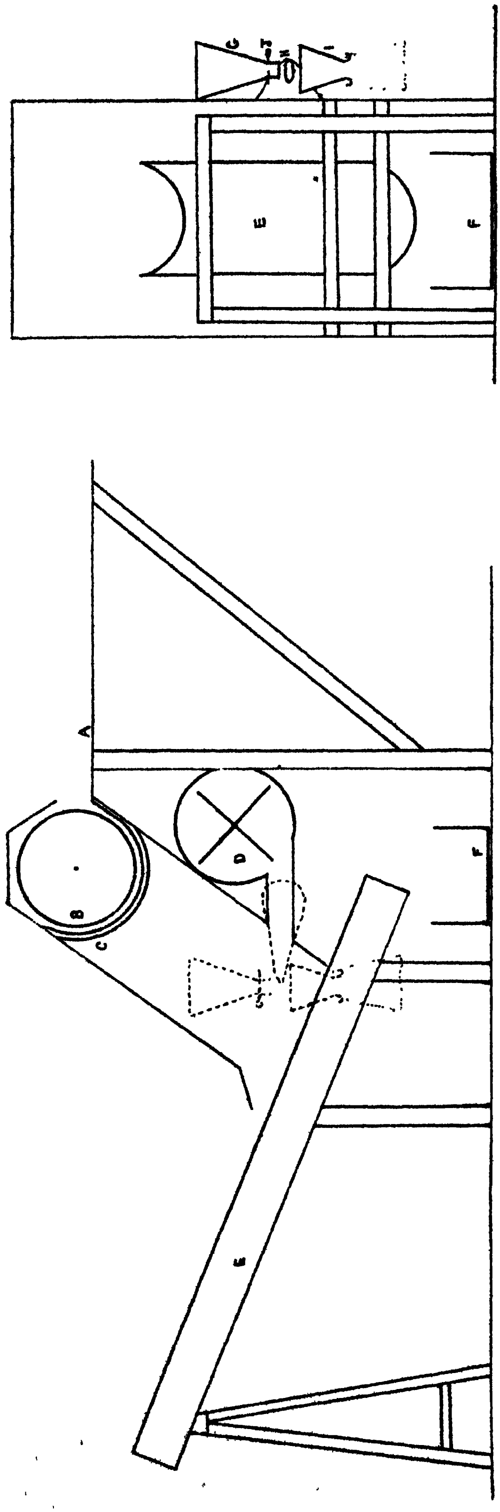

FIG. IV.—Rod-row Thresher.

A = Feeding Platform; B = Drum; C = Concave; D = Blower; E = Long Tin Chute; F = Removable Hopper; G = Hopper of Cleaning Apparatus; H = Nozzle from Blower; I = Funnel to catch grain and provided with hooks for attachment of bag; J = Screw for regulating the rate of flow.

carried by the air right over the lip of the funnel and is disposed of in this way.

C. *A method for estimating the Yields of ordinary Field Crops.*

A square frame is made accurately to enclose the area of $\frac{1}{1000}$ acre. This is taken to the field where the estimation is to be made and laid down so that it surrounds a portion of the crop; this portion is then cut out with a hook, and bound. The frame is then carried to other nine places in the field, the enclosed crop being cut out in each case. The operator thus endeavours as far as possible to obtain a very representative sample of the crop. The ten lots obained in this way will be the produce of $\frac{1}{100}$ acre. The yield is obtained by weighing and threshing in the usual way.

D. *Method of estimating the Yield of Forage Crops.*

Forage crops are usually grown by broadcasting the seed on $\frac{1}{100}$, $\frac{1}{50}$ or $\frac{1}{40}$ acre plots. The method of ascertaining the yield is to weigh the whole bulk of the forage immediately it is cut, and at the same time to weigh on an accurate balance a small representative sample. The bulk of the crop can then be made into hay or used for soiling stock, but the sample is taken to the laboratory in order to estimate its total content of dry matter. From the figures thus obtained the yield of dry matter per plot can be computed. Forage yields are almost invariably given in terms of dry matter per acre.

Fig. V. shows operators at work recording the weights of forage crops.

THE FIXING OF FARM WAGES.

JOSEPH F. DUNCAN,

Secretary, Scottish Farm Servants' Union.

THE information given by the Minister of Agriculture in the House of Commons and published in the last issue of this Journal (pp. 333-4) as to the regulation of agricultural workers' wages in certain countries in Europe, shows how difficult it is to get any precise knowledge of the systems in the different countries. Even where it would appear that machinery exists for statutory regulation, it is difficult to discover whether the legislation is effective or not. Acts which appear in the statute books of the various countries do not always "run," and that is particularly true of the land legislation of the new states of Eastern Europe. They are more often evidence of good intentions than of accomplished facts. Generally speaking, however, the legislative regulation of agricultural wages in Europe is merely the extension to the agricultural industry of the machinery for collective bargaining in fixing wages adopted for other industries. The tendency is not to make special provision for agricultural wages as it has been in this country; rather the reverse is the case, and the landworkers in

Europe spend a large part of their efforts in endeavouring to secure for the agricultural worker the benefit of the social legislation already in force for industrial workers.

All the signs point, however, to the social conscience in every civilised country becoming more sensitive to the social conditions of the agricultural workers. Naturally, in countries where the peasantry form a very much larger proportion of the working class than they do in this country, efforts have chiefly been devoted to the break up of the large estates and the creation of peasant holdings. The development of that policy is not likely to lessen the force of the demand for improvement in the conditions of the wage earners in agriculture, but is more likely to intensify that demand; and we may expect to find the legislatures of Europe spending more time considering the social conditions of the land workers.

In England, Parliament has gone further in the way of regulating the wages of farm workers than in any other European country. Provision has been made for enforcing a statutory minimum wage for all farm workers. The farm workers in Scotland, after an experience of similar legislation under the Corn Production Act from 1917 to 1921, made it clear that they did not want to be included in the new Act, and so its operation is confined to England and Wales. It is worth while considering the reasons why the Scottish farm workers do not desire a statutory minimum wage. They have no theoretical objection to State intervention as such; they recognise that the community is entitled to insist on a standard of living for any class of worker, and if they believed that there was no more effective way than by enforcing a statutory minimum they would press for that, as the English farm workers have done. The difference between them is not as to the end to be achieved but as to the best way of reaching that end. Nor should it be assumed that the farm workers in Scotland are satisfied with their present wages and conditions. In common with all workers they are making their own efforts to secure the improvements they believe to be necessary, and their methods of action may vary from time to time as circumstances dictate; but for the present they believe they are better without a legal minimum wage.

The force of the demand for a statutory minimum wage in England is derived from the state of affairs in the southern counties. Conditions there are quite different from those in Scotland. Even in the lowest paid counties in Scotland, if the value of perquisites is taken into account and allowance is made for continuity of employment, the earnings over the year will average ten shillings a week above those obtaining in England. The Scottish farm worker has always been the best paid wage earner in agriculture in Europe. This may be partly due to the fact that he has always been better educated in the past, and hence has had a wider range of opportunity in marketing his labour. He has not been tied to agriculture as his only way of gaining a living, and he has been ready at all times to seek for better employment. The decrease in the number of farm workers employed during the past fifty years has resulted in there never being a surplus of labour at any time. It has been notorious that the supply of labour has never

been sufficient for the demand, so that even in the period of agricultural depression the Scottish farm worker maintained his standard of living through the economic advantage which the scarcity of labour gave him. The traditional readiness of the Scot to fare furth of Scotland in search of his fortune has been shared by the farm worker in full measure, and emigration has played its part in maintaining the bargaining power of the farm workers.

We have to remember, too, the effect of the Scots system of making engagements at hiring fairs. At regular intervals during the last hundred years that system has come under vigorous attack from various directions, but the system has persisted with little change until in certain districts collective bargaining introduced modifications. In themselves the hiring fairs are a rudimentary method of collective bargaining. They bring together employers and employed, and raise at stated intervals the question of what the rate of wages is to be in the district. They give a rough idea of what the supply of labour is in the area and of the likely demand, and with all their disadvantages they have enabled the workers to estimate in a crude way what were the possibilities of marketing their labour. No one with any considerable experience of hiring fairs will desire to commend them as a rational means of settling wages or making contracts under modern circumstances. The most enlightened amongst farmers and workers would welcome any better method that would supersede the hiring fair, and already beginnings have been made in adjusting wages by collective bargaining; but in considering any proposals for dealing with wages of farm workers in Scotland their effect has to be remembered. They have increased the mobility of the farm workers, enabled them to become more independent, and helped them to take fuller advantage of the economic power which the scarcity of labour has given them. It is not without significance that the farm workers in England have always secured better wages in those districts where the hiring fairs have been customary.

The argument for establishing a minimum wage for farm workers is usually based on the alleged inability of those workers to organise to protect themselves as other workers have done. No one with any experience of organising agriculturists, whether farmers, smallholders or farm workers, will say that it is a simple matter. In the nature of things the work will always be difficult, although the development of the industry, the extension of transit facilities, the spread of the press, and now the development of wireless, are all tending to reduce the isolation of rural dwellers and to ease the work of creating a community spirit. However great the difficulties, there is no reason for hopelessness, and quite remarkable developments have been made in recent years. But as it stands the argument for a legal minimum wage is a confession that the method is a second best, and something in the nature of a desperate remedy to cure a desperate disease. If we are considering a body of workers living at a standard denoted by 25s. a week, there is force in the argument. If the workers cannot escape from that condition by their own efforts, some form of crutch must be provided, but a crutch is nothing but an encumbrance to a man with a pair of healthy legs.

As I have shown, the Scots farm worker, even without organisation, was able to look after himself fairly satisfactorily. Wages in agriculture in every country have always been distinctly below those of industrial workers, and in Scotland industrial employment attracted the best of the farm workers. But the difference between the standard of living of the farm worker and that of the industrial worker was never so great as to justify the term sweated worker being applied to the farm workers. It was rather in the social conditions of the farm workers, and the excessively long working hours and lack of leisure that the farm worker lagged behind other workers; and that has been in part redressed in recent years by organised action. In earnings the farm worker in Scotland is not so distinctly below the standard of other workers as to require special legislative protection for him. He is able to fend for himself if he has the will to do so, and it is sound principle that people should be encouraged to self effort rather than be encouraged to look for assistance from without. The healthy fact is that the Scots farm worker prefers to trust to his own efforts, and not to petition Parliament to intervene on his behalf.

That was the position when the Corn Production Act was passed in 1917. There was no demand for it in Scotland, and the Scottish Farm Servants' Union, when the Bill was introduced, did its best to have Scotland excluded from the section of the Act setting up Wages Boards. Parliament would not agree to this, but modified the provisions to enable the Act to be operated by Committees representative of the employers and workers. The experience of these Committees confirmed the objections of the workers to the policy of fixing minimum wages, and the repeal of the Corn Production Acts, and the consequent abolition of the Wages Committees, went through without protest from the workers and with their consent.

The method of fixing minimum rates by statutory bodies could not have been tried under more favourable circumstances than during the years 1917 to 1921. The industry was passing through a time of unexampled prosperity. No problem emerged of adjusting wages to the capacity of the industry. The farmers were able to pay much higher rates than were demanded by the workers, and these were much above the rates fixed by the Committees. The farmers were guaranteed prices for wheat and oats, and there was no economic pressure making it worth while for employers to attempt to evade paying the rates fixed. The whole conditions were abnormal and such as to make the working of a legal minimum much easier than could be hoped for under ordinary conditions.

In most of the twelve districts into which Scotland was divided the work of the Committees had little or no effect on actual wage rates. For the adult male workers the rates fixed ranged from 10s. to 15s. a week below the rates actually secured by the workers by collective bargaining between the Farmers' Union and the Farm Servants' Union, or in the hiring fairs. In the District of Dumfries and Galloway the rates fixed by the Committee more nearly approached the rates actually paid, and in the South-West Highlands and the North-West Highlands, where comparatively few farm workers are employed, and in Caithness, Orkney and Shetland

the minimum rates became the actual rates paid. In these districts there was no effective organisation of the workers, and although the minimum rates fixed meant actual increases in wages to the workers, the increases in their wages during the years of high prices were much less actually and comparatively than those secured by the workers in other districts. Even inside those districts there were local areas where the workers refused to accept the minimum rates fixed by the Committees as the actual rates of wages, and were able to secure higher rates by direct negotiation, or by holding out for higher rates at the hirings.

Little real damage to the interests of the farm workers was done by the Wages Committees, except in those districts where the workers trusted to the Committees instead of to their own efforts; but the circumstances were abnormal and the position was favourable to the workers. They could afford to leave the minimum rate standing at 36s. a week, as they did in one District, when they were negotiating a rate of 51s. with the farmers. In that District the Committee performed its statutory duty and fixed a rate in 1918, but never again considered the rate, and the workers never asked the Committee to do so. They simply ignored the minimum rate and went ahead with the work of fixing their own rates. It was felt that the whole thing was unreal and had no relation to the actual facts of the situation. The position might have been different had wages been falling. It may be said that the Committees might then have been a protection to the workers by preventing wages from falling too far. We can only judge what the work of the Committees would have been under such conditions by what they did when in being. The workers have no reason to believe that Committees which fixed minimum wages from 1918 to 1921 at rates which are substantially lower than those secured by the workers to-day, allowing for the altered value of money, would have fixed higher rates to-day when the industry is not so profitable to the farmers. The Committees would have been much more likely to fix lower rates, and so have tended to depress the actual wages below what they are to-day.

Although the Corn Production Act laid it down that the rate fixed for an able-bodied male workman must be sufficient "to enable a man in an ordinary case to maintain himself and his family in accordance with such standard of comfort as may be reasonable in relation to the nature of his occupation," the rates fixed were never defended on the ground that they were rates on which a family could reasonably be maintained. They were fixed at a rate which had in view the least efficient man employed by the farmers. There was no direction of that kind in the Act, whatever the intention of Parliament may have been, but the practice in Scotland was to fix the minimum rate on that basis. This was in direct opposition to the practice where wages have been fixed by collective bargaining and against the customary method of arriving at the market rate in the hiring fairs. Where wages have been fixed by collective bargaining, and at one time as many as half the counties have had wages fixed in this way, the practice has been to fix a rate for the ordinary married skilled ploughman and leave the other rates to be adjusted by individual bargaining.

taking the rate fixed for the skilled ploughman as a standard. It is the natural system in an industry where the large majority of the workers are skilled workmen, and where there is little scope for the unskilled and inefficient worker. It is a matter of small moment to the large body of skilled farm workers to find out what is the lowest wage a farmer may legally pay to the least efficient worker he employs. It is of real moment to him to know what the standard wage is for the man of ordinary skill. In collective bargaining the representatives of farmers and workers were merely following the practice which had grown up naturally in the days before organisations were formed. When farmers or workers speak of the market rates ruling at a hiring fair, they mean the rates paid to the ordinary skilled worker and not the special rates for the more highly skilled or the less efficient. There was real danger for the workers, therefore, in the introduction into the industry of a new system which attempted to bring a rate into being which had no real relation to the facts of the industry, but which must tend to depress wage standards.

Experience in the districts where there was no effective organisation of the workers, and where the hiring fairs had no part in fixing the rates of wages, showed that the minimum rates fixed became the standard rates; and it is significant that in England, although the rates were always issued as minimum rates, the discussions show that both sides were frankly working to fix the actual rates paid in the industry, and the rates fixed were those paid. The argument that the more skilled workmen would receive higher rates than those fixed on the basis of the inefficient worker was not confirmed by experience. The least efficient worker in a district where the standard wages fixed by collective bargaining were 10s. to 15s. a week above the minimum rate had no difficulty getting more than the minimum rate. The skilled worker in the West Highlands and in Caithness and Orkney had to accept the minimum rate, because it was accepted as the standard. The old custom proved more powerful than the new Act.

Whatever one's views may be about the advantages or disadvantages of standard rates of wages, unprejudiced observers must admit that in every industry the tendency is for standards to become established. They are not the creation of trade unions. They have existed in Scottish agriculture for generations, and were quite as definite at the end of the 18th century, as the Statistical Account shows, as they were at the close of the 19th century. All that the trade union or the employers' association does is to adopt a more scientific method of adjusting the standard. But every industry finds from experience what method of adjusting its standard suits the industry best, and in Scottish agriculture there has been no effort either by employers or workers to fix a uniform rate. Scottish agricultural work is skilled work, but without a definite apprenticeship system. It has to adjust its standard to meet a great variety of conditions of employment. It has worked out its own method to meet its needs, and it works well on the whole. We may all have ideas as to where and how improvements may be made, but those with experience and knowledge will rather work to improve the method we have than attempt to

give the industry a method that is completely new and strange to it.

There is another ground on which the creation of Wages Boards is advocated. They are proposed as a temporary machinery to enable the industry to organise itself to conduct collective bargaining. The end desired is collective negotiation of wages, but it is contended that it is necessary to give compulsory powers to enforce the rates fixed. It may seem that there is little difference here between the advocates of Wages Boards and the position taken by the Scottish Farm Servants' Union. Yet there is a wide difference. It may be true that you find the same people gathered round the table whether the meeting is that of the statutory Wages Committee, or the conference between representatives of the Farmers' Union and the Farm Servants' Union, yet the bringing in of the compulsory power of the State makes all the difference. Where the representatives of the two Unions are negotiating without any power to compel decision, except such power as either organisation can secure by reason of its economic position in the industry, the onus is laid on both parties to improve their organisation and to exercise their full power within the industry. The workers must accept the risks of pushing their claims; the employers the risks of depleting their labour supply. Whatever adjustments have to be made to meet the varying demands must be met within the industry itself. If the employers have to meet higher wages they must improve their output or reduce costs; if the workers have to submit to lower wages they must improve their organisation or seek employment where better wages can be found. There is no appeal outside the industry itself. Where the parties meet as members of a statutory Wages Board with compulsory powers, the negotiators do not accept the same risks. They have not to back their demands by withdrawing labour or by paying off workers. The immediate effect of their actions may be the same, but the reactions are very different. The representative without the compulsory powers of the State behind him must be careful not to attempt to go beyond the power of the organisation he represents; the representative on a Wages Board is not limited in the same way. His power comes from outside the industry, and can be exercised with less responsibility because it does not rest on the people he represents. Nor is the industry likely to respond in the same way in adjusting itself to the changes enforced. Both sides will feel that the appeal is always outside the industry, and their efforts will be devoted to influencing the statutory body and not to the adjustments necessary within the industry itself. In the long run the worker will fare better if he trusts to his own efforts to improve his wages. The problem is not merely how to secure better wages, but how to improve the industry so that it can pay still better wages. That problem is more likely to be solved if the people most concerned accept the full responsibility for their actions in the industry and make the effort to solve it for themselves.

FARM PESTS—BIRDS.[1]

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(2) DESTROYERS OF POULTRY AND EGGS.—The destroyers of the farmer's live stock might almost be grouped according to size, for it is apparent that only birds of some bulk could be responsible for the death of such as lambs or weakly ewes. On the other hand poultry and their eggs are liable to fall ready victims to the lesser birds of prey and other roving thieves. There is, of course, no inherent reason why the larger birds with carnivorous instincts should not also lay siege to the poultry yard, but in practice they seldom do so. The reason is not far to seek; their abstention is less a matter of taste than a question of expediency. Whatever may have been the state of affairs in the more natural conditions of former times, the larger birds, partly because man pursued them more strenuously since the damage they caused was greater, partly because they were more easily slain simply on account of their size, have in general been driven to the wilder regions. They have become shy of man and shun human habitations. They still fall foul of the farmer's interests on bleak and almost uninhabited sheep-runs, but they have forsaken the neighbourhood of the farm, where their lesser cousins, less persecuted and less shy, now find scope for their raids and their cunning.

It almost goes without saying that the enemies of the poultry yard belong to those very groups of birds that were responsible for destruction amongst the sheep flocks. But on the whole they cover a rather wider range. Thus although several of them are birds of prey, and some are of the diurnal or day-light raiders, one or two alleged raiders belong to the nocturnal series of owls, unrepresented amongst the larger destroyers. As for the remainder, they are of the semi-carnivorous families of the crows and the gulls.

Birds of Prey.—The Sparrow Hawk.—Of the birds of prey which may be regarded as farm-yard pests at the present day in Britain, the sparrow hawk (*Accipiter nisus*) is the most destructive. This is in part due to its rapacity, but more to its numbers, for next to the kestrel it is the commonest of our hawks. Almost wherever there is sufficiency of woodland it is to be found, since woods, especially in cultivated regions, afford it easy proximity to its food-supply.

It is distinguished by its size, colouring and especially by its long yellow legs, the lower part of which is bare of feathers. The male bird is some 13 inches long from beak to tip of tail, with wings just under 8 inches in length. The adult is slaty grey above, with under parts white with reddish bars. As is general amongst hawks, the female is larger, 15 inches long with wings

[1] Articles in this series, dealing with Mammal Pests, commenced in the *Journal* in July 1922. The first article on Bird Pests appeared in the January number of the present volume.

rather over 9 inches, and her colour is browner on the back, while the bars of the under surface are darker brown in colour, sometimes even dark grey.

From Saunders'] SPARROW HAWK. [Manual of British Birds.

The sparrow hawk generally nests in a fir tree, building a rather rough flat nest of fir twigs, lined with fir bark and down, at some height against the trunk of the tree. Here, about May, four to six eggs are laid, round reddish brown eggs, with the colour thickly splashed over a greenish white ground. As a rule only one clutch is laid in a season, but should this be destroyed, the birds, unlike the eagle, set about preparing a second nest in which they may hatch a brood.

The flight of the sparrow hawk is swift and silent. It generally flies low along hedges or by the undergrowth on the margin of a wood, seeking small birds. I have seen one, on the hunt, silently thread the trees of a young fir plantation and land noiselessly on a stone dyke a few feet from where I watched. In pursuit of its prey it acts with great impetus, dashing with full force upon its victim, which it tears to pieces upon the ground.

There is little difference of opinion regarding its food. As a rule it feeds upon insects, occasional mice, and small birds such as blackbirds, sparrows, larks, or upon larger birds such as wood and domestic pigeons. Unfortunately it pays frequent visits to the farmyard, swooping upon and carrying off a chick before it has an opportunity of seeking shelter or protection. Under stress of hunger, particularly when the nestlings are making their somewhat inconsiderate demands, the old birds show great daring, and at least one case is on record of a descent made in a city courtyard, surrounded by houses, to seize a half-grown chicken amidst a flock of fowls.

It is not only because of the direct injuries it inflicts that the sparrow hawk may be looked upon as somewhat of a nuisance to

agriculture. Its staple diet of small birds, while it includes some the farmer could well spare, includes a larger number of insectivorous birds, from the activities of which the farm benefits. Occasionally mice and even frogs are eaten, but the consensus of opinion of the witnesses examined before the Scottish vole plague committee, was definitely that the sparrow hawk did not habitually destroy mice and voles.

The weight of evidence from the farmers' point of view is clearly against the sparrow hawk, and the game-preserver would undoubtedly add his testimony in the same sense.

At the present time this species is protected at no season of the year from the owner or occupier of land, and the general trend of opinion is indicated by the provisions of the new Wild Birds Protection Bill, which, though it has passed through the House of Lords, has not yet become law. Here a generous protection is granted to all hawks, but the sparrow hawk is specifically exempted, and would, on the passing of the Bill, stand in exactly the position it occupies to-day as regards protection.

The Kestrel.—Commonest of our hawks, the kestrel or windhover (*Falco tinnunculus*) is distinguished by its slate-grey head, tail and tail covers, rich reddish brown back with black triangular spots, and reddish buff under parts spotted with black on throat and breast. In size of body it closely resembles the sparrow hawk, about 14 inches from beak to tip of tail, but its attitude, when perched, is dumpier, owing to the comparative shortness of its legs, the lower segment of which (tarsus), 1½ inches long, is almost an inch shorter than that of the sparrow hawk, while its long pointed wings contrast strongly with the rather rounded wings of the latter. Perhaps the most characteristic feature of the kestrel is its habitual hovering, an almost motionless suspension in the air while its sharp glance scans the vegetation below for a movement which would betray the presence of a small bird or mammal.

The kestrel generally frequents moorland and open fields, but it is at home amongst the sand-dunes as well as in woods. It is content with a scanty nest little better than a "scrape," on the ground or on a rocky ledge, in a tree or a ruined building. The eggs, four to six in number and blotched with reddish brown on a creamy ground colour, are laid in April or May. The flight of the kestrel is in the open, exposed, very different from the lurking bush-to-bush search of the sparrow hawk.

I have been at some pains to draw a distinction between these two hawks, because confusion regarding their identity and distinctive habits has sometimes led to needless slaughter of a hawk that is more sinned against than sinning. The kestrel has been accused of destroying chicks in the farm-yard and game in the breeding fields, and although the accusation has been well-founded in many cases, it would be a mistake to regard these as anything but an abnormal diet. Universally it feeds upon mice and voles, caterpillars, beetles and other insects.

Its bad name is due to desultory raids upon chicks of game or poultry, but it is now generally agreed that these raids are usually the work of a "rogue" individual which has learned bad habits, and that when the thief is shot the raids come to a sudden end.

Every worker who has examined the food content of kestrels has come to the conclusion that the good they accomplish infinitely exceeds the harm. Professor Newstead's investigation of nineteen birds and fifty-seven food pellets, revealed the fact that over seventy contained voles or mice; two, birds; one, a frog and several insects of indifferent groups, and Dr. Collinge's researches have fully confirmed those of his predecessor.

The farmer and game-preserver would do well to consider the balanced statement made by C. F. Archibald in the Journal of the Royal Agricultural Society for 1892; it is as true to-day as thirty odd years ago. "Three facts about the kestrels should always be borne in mind. The first that they very frequently bring up their young within easy reach of hand-reared game without taking a single chick, but, notwithstanding the temptation, continue to lead a life of harmless utility. Secondly, it is only during a very brief period of the game-bird's existence that any danger need be apprehended from the windhover, for it will not touch them except during their helpless infancy. Thirdly, throughout the rest of the year the kestrel does incalculable good by the destruction of hosts of field-mice and injurious beetles. The value of farm produce thus saved from destruction is almost beyond estimation. It is, therefore, a short-sighted policy to exterminate such beautiful and useful birds because they do a certain amount of harm, that harm being confined to a very few weeks in the year."

Under the present law *every* Scottish county that has issued a special county order for the protection of wild birds, through the agency of the Secretary for Scotland, has absolutely prohibited the taking or killing of the kestrel throughout the whole year. This substantial recognition of the usefulness of the bird is confirmed by the similar protection sought to be granted to it under the new Bill.

The Peregrine Falcon.—None of our hawks is more pronouncedly a "fowl of reif," as the old Scots had it, than the peregrine falcon (*Falco peregrinus*). Its courage and audacity are extraordinary, its energy prodigious, and the rapidity and strength of its flight are in keeping with its strength, so that, as Mr. Coward well says, "the rush of a stooping peregrine when heard at close quarters is like the sound of a rocket." It is larger than the species already mentioned, from the 15 inches length of the male to the 18 inches length of the female, the wings of the two sexes measuring respectively 12½ and 14 inches long. The plumage of the adult is slate grey on the upper parts with indefinite darker bars, the crown and sides of the head are sooty black, and the under parts are white tinged with buff, spotted on the throat and upper breast and barred with dark brown on the lower breast. The lower part of the leg (tarsus) is yellow and half feathered.

On rocky coasts and craggy places inland it generally has its eyrie, but its numbers are limited by the fact that each pair allocates to itself a territory of some six to eight miles radius within which stranger peregrines dare not venture. Even so it is less common than it used to be, for it has been for many years persecuted by farmers and game-preservers, although once on a day, because of

its value as a hawking-bird, it was most strictly preserved. In view of the persecution to which the peregrine is subjected, it is remarkable how quickly good nesting sites, the tenants of which have been slain, become re-occupied by a fresh pair. The re-population is probably to be accounted for largely by the settling down of immigrant birds from Scandinavia.

The eggs, two to four in number, rich amber brown in colour, are laid simply upon a rocky ledge, for no real nest is made. The time of laying is in April, and although a single brood is the rule, the destruction of the first may lead to a second laying.

The peregrine feeds upon birds of almost any size. It is a constant threat to birds on migration, seizing passerines on the wing and carrying them off without alighting. At Fair Isle, Dr. Eagle Clarke found that it subsisted mainly on herring-gulls and migrating woodcock, and on many a frequented route its presence accounts for the non-appearance of homing pigeons. On the sea-shore small waders are often killed, but it does not hesitate to attack and destroy birds as large as itself, ducks, gulls and curlew. On sea-cliffs it plunders the nests of the cliff-nesting birds when the young have hatched, and feeds also on adult guillemots, gulls, puffins and the like. Inland, its ravages are more serious, for although many a rabbit and rook fall victims, its taste leans to game, such as grouse, black game and partridges.

When such dainty fare fails it, it will not hesitate to seize a duck or fowl even from the farm-yard. The farmer's consolation must be that game is not scarce in this country, and the peregrine is not common. The prey when captured is never eaten on the spot but is carried to a distance, and remarkable stories of distances traversed reveal the strength of the bird. Brand, in his account of Orkney and Shetland (1700), reports of the peregrines of Fair Isle that "sometimes they'll find Moor Fowls in their nests which they are believed to bring from Orkney, seeing there are none in Zetland, and the nearest isles they could have them in were Stronza or Westra, which is between 40 and 50 miles of sea, over which at one flight they must carry these fowls to their nests."

Under the schedule of the present Wild Birds Protection Acts the peregrine falcon is afforded no special protection, but most of the County Councils of Scotland, through special orders of the Secretary for Scotland, prohibit the taking or killing of it throughout the year, on account of its increasing scarcity. In the wilder counties, however, where its numbers still make it troublesome, it is protected at no season of the year from the owner or occupier of land; this is the case in Sutherland, Ross and Cromarty, Argyll, Forfar and Wigtown.

Other Hawks.—Time was when the poultry yard paid toll to other than the few hawks I have already mentioned, but these have now become almost extinct in this country, or at any rate so scarce that their presence no longer counts. The Kite (*Milvus milvus*) was once a common bird in Britain, but by the middle of the nineteenth century it had been driven to the wilder counties, and now it has ceased to be a native bird in Scotland, though it still survives on the wild borders between England and Wales.

I am afraid that the love of the "greedy gled" for the tenants of the poultry yard had much to do with its disappearance—

"Other losses too the dames recite,
Of chick and duck and gosling gone astray,
All falling preys to the swooping kite:
And on the story runs from morning, noon and night."

Of the Harriers, the same story almost holds good. The Hen Harrier (*Circus cyaneus*) especially, as its name indicates, once played havoc with the good wives' stock. Yarrel says that the name Harriers has been almost certainly conferred upon these birds "from their marauding disposition, since the plundering propensities of the conspicuously coloured males of the species next to be described [the Hen Harrier], must have made them in old times a well-known terror to the poultry wives of the districts bordering on their haunts." And again, regarding this particular species, he says:—"They have been considered to be particularly destructive to the eggs and young of gallinaceous birds, and consequently their destruction has been much compassed by those who desired to preserve their poultry and their game, though the almost entire disappearance of this and the other species of Harriers from their chief haunts in the East of England is due rather to agricultural improvements which have brought into cultivation large tracts of what was formerly waste land." In Scotland the hen harrier now nests solely in the Orkneys and Outer Hebrides, and only odd pairs have bred recently in two or three English counties. Owing to their rarity these birds are protected in most of the counties.

The Destruction of Hawks.—The trapping of hawks is a fine art to which much attention has been given in parts of the Continent, where the variety and numbers of destructive hawks are greater than here. On this subject M. de la Rue, a former inspector of forests in France, makes some pertinent remarks in a work on "Animaux nuisibles," published some years ago in Paris. He says in effect: "I do not regard as a skilled trapper anyone who is not familiar with the habits of animals; and this is as true for birds as for beasts of prey. It may chance that a fox is taken in a wolf-trap, and *vice versa*, or that a beech-marten, a pine-marten or a wild cat may be captured in a trap set for a stoat; but a peregrine falcon is never taken in the special trap set for a goshawk, any more than a sparrow-hawk lands in the trap placed for a buzzard. It is necessary, therefore, to choose, place and set the trap which conforms to the bird desired to be captured, taking stock of its habits, and I may venture to add, its tastes."

French traps, following this dictum, appear in many patterns, most of them modifications, more or less complex, of the two-jawed iron spring trap. It is unnecessary, however, to follow the details of their structures, for they are almost all used as pole-traps, and this deadly and cruel instrument is prohibited by law in Britain. As reports appear stating that it is still occasionally in use, it may be well to repeat the words of the Act of 1904. "Every person who on any pole, tree or cairn of earth or stones

shall affix, place or set any spring trap, gin or other similar instrument calculated to cause bodily injury to any wild bird coming in contact therewith" shall be liable to a penalty of forty shillings. Every person who shall permit such trap to be so affixed shall be equally liable.

Although some hawks are captured in nets, in which they become enmeshed in stooping at a living bait, this method is only employed when the birds are to be taken alive for hawking; so that the means of destruction are in practice almost limited to shooting. This is generally carried out at the nest during the period when the eggs are incubating, the fact that both parents brood bringing one after the other within easy range of a concealed gun. Hawks, however, may show great wariness and suspicion, so that both approach and concealment call for some care. The destruction of their eggs is less effective in the case of hawks than with eagles, on account of the habit of the former of laying a second clutch should ill befall the first.

More than once I have emphasised in these notes the importance of numbers in determining the harmfulness of a pest. It will be gathered from the preceding account, therefore, that hawks are less destructive in the poultry yard than the evil reputation of a few would warrant, and that their destructiveness is a gradually diminishing quantity. During the last few years large numbers have been killed in Argyllshire by a recently founded vermin club, but the indictment against them is based on game and not on poultry. The old vermin books contain many records of extensive slaughter, such as the "2520 hawks and kites" killed in the ten years from 1776 to 1786 in five parishes in western Aberdeenshire, the 1115 hawks destroyed in seven years, 1819 to 1826, on the estates of Langwell and Sandside in Sutherland or the 1055 slain in the Sutherland estates in the same county in the three years 1831 to 1834. But that was long ago, and since these days the hawk nuisance as concerning the poultry yard has been reduced to very small proportions.

It cannot be out of place, therefore, to make appeal for a reasonable instead of an excessive slaughter of the remaining hawks. Indiscriminate killing at sight of any and every hawk is more than a mistake, it is bad agricultural policy, for many of the hawks,—the kestrel, the merlin, the buzzard, to mention a few,—do more good than injury to the farmer. The wise course would be to shoot only the most destructive species, and of the other species only individuals which have turned thief and have been caught in the act.

Owls and the Poultry Yard.—Of two species of owls it has been alleged that they occasionally lift chicks of game and poultry—the long-eared Owl (*Asio otus*) and the Little Owl (*Athene noctua*). These misdemeanours, however, are so rare, and examination of the food pellets and food content of the birds has shown so definitely that their diet consists mainly of small rodents, small birds and insects, that they need not be further considered in this connection. The former is the commoner in Scotland, and as it is the only Scottish owl against which the farmer or game preserver can have any reasonable cause of complaint, a character-

istic illustration is inserted here showing the two sets of elongated feathers on the head, from which the bird derives its name and the presence and length of which distinguish it from other owls. I shall have occasion later to refer to this species in connection with its indirect effects upon agriculture.

From Saunders'] LONG-EARED OWL. [*Manual of British Birds.*

The long-eared owl is a nocturnal or twilight hunter, and in this respect differs from the Little Owl, which is given to daylight ranging. The latter, however, has scarcely yet penetrated to Scotland from the English centres to which it was introduced in 1843 and later from the Continent, and from which it has spread over a great part of England.

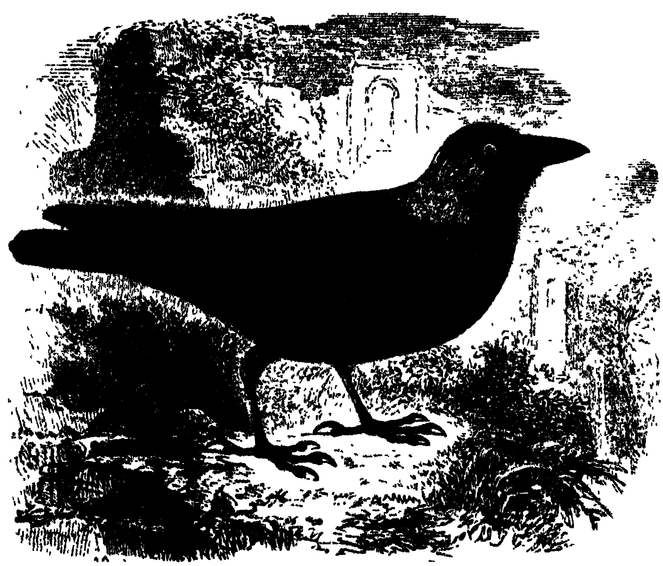
Crows and Gulls.—Reference has already been made to the destructive work of certain of the larger crows and gulls (p. 279 *et seqq.*). It is only natural to suppose that where these birds are common they do not confine their attention to lambs, but raid the poultry yard as hunger compels and opportunity offers. Their guilt differs in degree of blackness. Thus the Carrion Crow will seize any small living thing it can conveniently overcome (chicks fall comfortably within this category), and it is besides a persistent stealer of the eggs of game-birds and of poultry when they are available. But the Hooded Crow, closely related though it be to the other, has an even worse reputation as an egg and poultry thief. Of it Swaysland says in his *Familiar Wild Birds* (1893): "Its powers of mischief in respect to the poultry-yard during breeding time are so exceedingly well developed that as late as the year 1835 the different local authorities of Shetland and

Orkney were in the habit of paying 2d. for each crow killed in their districts." And there are still districts on the mainland where a price rests upon its head. The audacity of its egg-stealing is almost beyond belief: there are several well-authenticated cases (some mentioned by Gray in his *Birds of the West of Scotland*) of the rifling of the nests of golden and white-tailed eagles, the crows actually lying in wait to seize the opportunity afforded by the departure of the eagles from their eyries.

Of the gulls, the Great Black-backed and its smaller fellow the Lesser Black-backed Gull (*Larus fuscus*) are both fond of the eggs of other birds, and have been known to destroy an unguarded chick, but the thickly tenanted cliff or sea-shore offers them more abundant and more accustomed fare.

Two members of the crow tribe, which have not yet appeared on our black list, must be mentioned here on account of their occasional excursions to the poultry-yard, although these are more than counterbalanced by the benefits the birds render agriculture through the destruction of harmful insects.

The Jackdaw (*Corvus* or *Colœus monedula*), familiar in most districts and even in our larger cities, is black, like its cousin the rook, with which it often associates, but it is easily distinguished by its smaller size, its shorter and less formidable beak, by the grey colour of the nape and sides of the neck in adult individuals and the leaden black of its under parts.



From Saunders'] JACKDAW. [*Manual of British Birds.*

The Jackdaw has gained a redoubtable and traditional, it might almost be added legendary, reputation as a thief. The allegation that it does harm to chickens, pheasants and partridges is an old one. It certainly destroys eggs and young birds in season, and occasionally steals poultry food; but its main food supply consists of insects, and the depredations of which it has been accused may

be due, as Dr. Collinge has suggested, to excess of numbers, to a scarcity of food or to "sheer depravity on the part of a few birds only." In any case, examination of the stomach contents has consistently revealed a preponderance of usefulness on the part of the Jackdaw, and this is the general opinion of observers as to its economic significance.

The Magpie (*Pica pica*) balances its account for the good less easily. It is a rarer bird than the Jackdaw, though its striking black and white plumage, long tail, and chattering cry make it conspicuous wherever it occurs. Undoubtedly the Magpie destroys the eggs and young of other birds, including those of poultry and game birds. To some extent this damage must be reckoned in its favour, for its attention is largely concentrated upon such birds as woodpigeons, blackbirds and thrushes, some of which the farmer could well spare. The sum of its misdeeds, so far as agriculture is concerned, is more than offset by its destruction of insects and occasional small rodents. Yet there is much difference of opinion as to its ultimate valuation. Dr. Collinge, in his *Food of Some British Wild Birds* (1913), seems to sum up the position very fairly: "Apart from the question of game, the magpie is a bird that is beneficial to the agriculturist, feeding, as it does, largely upon soil larvæ and beetles, while it destroys field mice, voles, blackbirds and woodpigeons." His analysis of an examination of the stomach contents of twenty-four examples certainly bears out his conclusion, and the investigations of other workers tend in the same direction.

AGRICULTURAL BOOKKEEPING IN DENMARK.[1]

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Historical.—Although some accounts for the larger Danish farms date back for a considerable period, there was no widespread movement for the extension of agricultural bookkeeping before the latter half of the nineteenth century. At that time many different people advocated, by speech and by writing, the keeping of farm records, while the "control" or milk recording societies, which commenced their activities in 1895, were also concerned with promoting the keeping of farm accounts.[2]

During this century the promoters of farm bookkeeping have worked in two different ways. First come those who have energetically encouraged farmers to keep their own accounts by means of simple account books specially prepared for the purpose on the principle of single-entry bookkeeping. Courses in this type of farm bookkeeping have been given to the teachers, so that they

[1] The writer has to thank Prof. O. H. Larsen and Mr. Axel Milthers of the Royal Veterinary and Agricultural High School for very valuable assistance in the preparation of this article.

[2] For a full account of the "Control Societies" see *Co-operation in Danish Agriculture*, by Harold Faber, pp. 109-122.

in their turn might organise local classes for practical farmers. This system has met with a considerable amount of success, but the great difficulty has been to get the farmers to persevere in the work. In contrast to the supporters of this method are the advocates of a co-operative system of bookkeeping, worked through the various agricultural societies, and it is this system which has proved a real success. There were two forces at work calculated to create interest amongst farmers in the keeping of farm accounts. The first was the gradual extension of the work of the Control Societies, many of which extended their activities to comprise the whole stock economy. The second was the frequent competitions for the promotion of good husbandry organised by the agricultural societies, many of which required the keeping of records of different branches of the farm. Such competitions organised by the Agricultural Society of Samsö (Samsö Landboforening) between 1902 and 1908 required that records of the whole farm should be kept. This was the origin of the formation of a bookkeeping association (Reguskabsforening) which was established in Samsö in 1910 as a branch of the local agricultural society for the purpose of keeping complete and uniform farm accounts. The "Associated Agricultural Societies in Zealand" were also pioneers in this work, and accounts kept by them in connection with various competitions date back to 1904. Since the formation of the Samso society other bookkeeping societies have been formed in rapid succession, so that for this year there are 55 societies dealing with a total of 2750 farm accounts. Like the original they are mostly branches of the local agricultural societies, and they are organised so that the farmer himself or his men keep the daily records, while the society's "consulents" or assistants make the monthly entries and the yearly closing on the principles of ordinary double-entry bookkeeping. These bookkeeping societies are recognised by the State, which, by the law of 28th May 1915, pays two-fifths of the salaries and expenses of the consulents. The grants are made subject to three conditions—the whole farming business must be included in the accounts; account books sanctioned by the local provincial co-operative committee must be used; the results must be completed and published.[1]

In 1910 a committee of the Royal Danish Agricultural Society (det Kgl danske Landhusholdningsselskab) was formed to promote the extension of bookkeeping societies and to encourage uniformity in their methods. In 1913 it published a series of farm account books which have since been used extensively by the various societies. It also advocated the extension of the work so as to enable the collection of sufficient data for an investigation into farming costs. The first investigation of such a kind made in Denmark was by Prof. T. Westermann in 1896, but this was not based on systematically kept farm accounts. Further activities of this committee, which summoned to its assistance representatives of all interested societies, resulted in 1916 in the formation of "The Bureau of Farm Management and Agricultural Economics" (det landökonomiske Driftsbureau). The plan for its organisation was the work of Prof. O. H. Larsen, who in due time became the

[1] See *Landökonomiske Aarbog* for 1924, pp. 106-107.

director of the Bureau. It works through the local bookkeeping societies, which furnish it with the completed farm accounts from which it prepares detailed statistical investigations for the student of farm economics. The results are published in an annual report. while the most important are incorporated in the official statistical year-book (Statistisk Aarbog). In no other country is such a research institute based on the co-operation of local bookkeeping societies. The Bureau is controlled by a committee of six members representing the various sections interested, viz. :—

(1) The Associated Danish Agricultural Societies (de sam: danske Landboforeninger).
(2) The Associated Danish Smallholders' Societies (de sam: danske Husmandsforeninger).
(3) The Royal Agricultural Society of Denmark.
(4) The Central Co-operative Committee (Andelsudvalget).
(5) The State Department of Statistics (det Statistiske Department).
(6) A nominee of all the above, who acts as the director of the Bureau.

The growth of the Bureau is given in the following statistics of the numbers of affiliated bookkeeping societies and the number of accounts dealt with :—

Year.	*No. of Societies.*	*Total No. of Accounts.*
1916-17	6	75
1917-18	8	235
1918-19	23	305
1919-20	29	371
1920-21	40	466
1921-22	47	500
1922-23	48	540

Thus 2492 farm accounts have passed through the Bureau, while during this year every bookkeeping society in the country contributes some accounts. In 1918 the Bureau was recognised by the State, which allows it an annual grant, amounting for the current year (1923-24) to 50,000 kroner or roughly £2000.

Analytical.—In the future the results established by this Danish research institute are certain to be used extensively by the student of farming costs in all countries. It is therefore very important that the principles on which the work is conducted should also be known, since then only will the real value of the results be appreciated. In this section only points of difference from our methods are given, while considerations of space preclude any discussion even of these.

Form of the Accounts.—Two forms of accounts differing in the degree of detail involved are allowed, and the farmers are at perfect liberty to chose either form. "*Form A,*" which is the simpler, requires only that separate accounts be given for the farm proper, for the household, for private affairs, and for any subsidiary undertaking that may be involved. "*Form B,*" however, requires a far more elaborate account for the farm. Here the farm account must have full divisions for the various branches

of the business, so that the annual accounts will give full information on the economy of all the departments of the farm. For the year 1921-22 the Bureau considered 157 accounts of the first type and 343 of the second.

This division of farm bookkeeping into two groups is suggestive in the light of the following recent statement by a Danish economist:—"It is sufficient that about 10 per cent. of the farmers keep really instructive accounts with proper divisions for the different branches. . . . Only an ordinary cash account can be expected of all, while detailed bookkeeping would often give results that would be less instructive than ordinary common sense. If we have 10 per cent. keeping good accounts spread over the country and amongst the different sized farms, their results may be useful even for the others, and the number will be quite sufficient for very instructive statistics."[1]

Principle of Valuation.—The method of valuation on a market value basis is still retained, and this must necessarily be a serious consideration in our estimation of the reports.[2] For permanent capital (land and buildings) the valuation for the property tax (ejendomskyld) is always used. This valuation, which is made every three years, is generally slightly lower than the actual commercial value of the farm. The live stock is also valued at a slightly lower figure than its commercial price. In all other cases current market prices are used, and the Bureau publishes every year a carefully prepared price list to be used in these valuations; in this list slightly lower prices are given for the valuation of articles passing from one department of the farm to another (*e.g.* cereals from crops to stock).

Of particular importance is the estimation of feeding stuffs in "*fodcrenheder*" or feeding units, where the unit is the feeding value of a kilogram of barley. This system is also used in the other Scandinavian countries, and it is used both by bookkeeping associations and by the milk recording societies.[3] The feeding stuffs are divided into two groups:—

(*a*) *Kraftfoder*—including concentrated feeding stuffs such as cereals, cakes, etc.

(*b*) *Grovfoder*—roots, hay, straw and grass.

The valuation of the feeding stuffs in the second group presents some difficulty, because of the possible absence of market prices for these articles. A rough valuation can be made by calculating the average price per feeding unit for the first group, and pricing the second group accordingly. This method is adopted in the valuation of foods supplied to horses and pigs. Roots, hay and grass are, however, so important in the feeding of cattle that such a rough valuation is considered too unsatisfactory in this case. The difficulty is overcome by the following method of closing the cattle account. The balance between the total expenses (ex-

[1] See "Danish Agriculture" by Prof. Jens Warming in *The Quarterly Journal of Economics*, May 1923.

[2] For a full discussion of the problem of valuation see *Farming Costs*, C. S. Orwin, chap. 3.

[3] *Ibid.*, Faber, pp. 121, 122.

cluding the cost of Group *b* feeding stuffs) and the total receipts is charged to the cost of Group *b* feeding stuffs consumed, thus leaving the account without a profit. Then the criterion of the cattle account for the year is the amount it shows as payment for these feeding stuffs consumed; in other words it is the price per fodder unit paid by the cattle for their consumption of roots, hay, straw and grass. A high price per fodder unit for these foods will indicate a good year for the cattle business, while it will also benefit the crop accounts by paying more for these crops. This interrelation of the cattle account and the crop accounts is important.

As in the method of Voelker and Hall, the valuation of the manurial residue of feeding stuffs is based on their conversion into *Kvælstofværdienheder* or nitrogen units, but here again current market prices have greater influence. The nitrogen content of any feeding stuff is given by the formula

$$K = x\,(N) + y\,(P_2O_5) + z\,(K_2O),$$

where $x = 1$ and $x:y:z$ represents the relative current prices of unit N_2, unit P_2O_5, and unit K_2O, as manifested in the existing prices of nitrate of soda, superphosphate, and sulphate of potash respectively. The Bureau publishes every year a complete list of feeding stuffs giving their nitrogen content per 100 kilograms and per 100 feeding units. To obtain the nitrogen content of the manurial residue a reduction is made for the consumption by the animals (25 per cent. for cows, 15 per cent. for young cattle, 20 per cent. for pigs and 15 per cent. for horses), and a further reduction is made for stored manure depending on the efficiency of the storing. Farmyard manure is then valued on the assumption that a nitrogen unit of it is worth 66 per cent. of a nitrogen unit of artificial manure, and this is easily obtained from the annual price list. The manure is charged to the crops (field accounts are rarely used) not in proportion to the amount applied, but in proportion to their respective nitrogen content, as this is supposed to represent the exact consumption of manure by the crop. The quantities of the crops are recorded, their nitrogen content determined from the tables, and the total manurial expense debited accordingly. There are, however, two important exceptions. First, the cost of all artificial nitrogenous manure is charged directly to the crop which gets it on the assumption that it is immediately consumed by that crop,—therefore a deduction equal to the nitrogen content of such manures must be made for that crop before its portion of the cost of the other manures is fixed. Second, a similar deduction equal to the amount of nitrogen taken up from the air is made for all leguminous crops. It will be seen that with this method the question of unexhausted manures does not arise. This is not such a serious omission as would at first appear, since the whole problem of compensation for improvements is quite unimportant in Denmark, where outgoing tenants are conspicuous only by their absence.

Determination of Wages of Management or Driftslederlön.—In all accounts a charge is made for the remuneration of the *entrepreneur*. Where a hired manager is employed this is easily

fixed by deducting wages for any manual labour done by him from his salary, the remainder then representing real wages of management. Hired managers are, however, very rare on Danish farms, so that this method is not often available. As a result of research conducted on the accounts of a number of farms where hired managers are employed, the Bureau has found that there exists a relation between wages of management, the size of the farm, and the intensity of the farming. Taking the property tax as the measure of area, and the agricultural capital as the measure of intensity, a scale based on this relationship has been drawn up for fixing the wages of management. Wages of management are charged to the productive accounts only. With the more detailed accounts of "Form B" it is charged to the various stock accounts, and to the total crop account in proportion to their respective labour expenses. Half the amount charged to the crop account is further divided amongst the various crops in proportion to their labour bills, the other half is divided in proportion to their area.

Method of Analysing the Accounts.—The annual report aims at giving a critical analysis of the whole farming business for the year. Its form is important since it represents a method of analysis of farm accounts which is used extensively in the Scandinavian countries. It is based on a strictly abstract conception of the whole farm economy and the treatment throughout is purely impersonal. Thus the accounts are treated not so much in their relation to the farmer as in their relation to the farm; it is not the owners of the capital invested that are considered but the capital itself.[1] As will be seen this method simplifies the treatment by excluding the more complicating considerations of tenure, etc. But to exclude such important influences as rent and mortgage interests has its drawbacks as well as its advantages. Although the former is comparatively unimportant in Denmark this is far from being true of the latter, when it is remembered that before the war the average mortgage of Danish farms was 43 per cent. of the value of the farm and live stock.[2]

The capital invested in the farm is analysed into permanent capital (Grundkapital) and working capital (Driftskapital). Permanent capital is represented by the value of the land and buildings, and working capital by the live stock, implements and machinery, together with the stores of feeding stuffs, manures, etc. The methods of valuation have already been discussed.

An analysis of the value of the gross production (Bruttondbyttet) based on its origin is shown in the first column of the accompanying diagram. It can also be analysed according to the manner in which the produce has been disposed, and such a method supplies the following careful analysis of the gross returns of a farm:—

(1) Income from direct sale of produce.
(2) Calculated value of produce delivered to household.
(3) Calculated value of produce used as payments in kind.
(4) Value of *real* increase in stores and in live stock. Increase in value due to price movements are not included, like-

[1] The Danish prefix "Drifts"—for which there is no exact English equivalent —signifies this abstract conception.
[2] See *ibid.*, Prof. Jens Warming.

wise all increases resulting from purchases of live stock are also excluded from the gross output.

Working expenses (Driftsomkostninger) are the total cost of producing the gross output, and will therefor be made up of—

(1) All money payments. But payments for the increase of any part of the agricultural capital, such as payments for the purchase of live stock, are not considered to be costs of production, since such increases are excluded from the production itself. Likewise interest, rent and personal taxes are also excluded, but the property tax (ejendomskatten) is included.

(2) Payments in kind to labour.

(3) Normal depreciation of buildings, cultivations, machinery and horses.

(4) Reduction in supplies of feeding stuffs, manures, etc.

(5) Calculated compensation for materials, etc. obtained by the farm account from any of the subsidiary accounts, *e.g.*, timber from the "forest account."

(6) Remuneration for manual work of occupier and family.

(7) Wages of management.

Alongside the last column of the diagram an analysis of working expenses, based on the way in which they have been incurred, is shown.

The difference between the working expenses and the gross returns gives the net returns (Nettondbyttet), which is represented by the unshaded portion of the second column of the diagram. The net returns may be considered as the actual interest on the capital invested in the business. In itself it is not an adequate measure of the success of the undertaking, but in every case it must be considered in relation to the size of the agricultural capital on which to such a large extent it depends. The net returns expressed as a percentage of the agricultural capital gives the "Forretningsprocent," and it is this which is taken as the standard of efficiency. It is very interesting to study its significance in the light of the recent discussion of the whole problem of standards of production in agriculture.[1]

"Nettooverskud," which is shown in column V., represents the net surplus remaining after deducting normal interest on capital from the net returns. (Normal interest is calculated thus—4 per cent. value of land, 5 per cent. value of buildings and cultivations, 6 per cent. value of stock and machinery, and 8 per cent. value of stores, or roughly 5 per cent. value of total agricultural capital.)

In column IV. the social output (Samfundsmæssigt Udbytte) is shown as consisting of

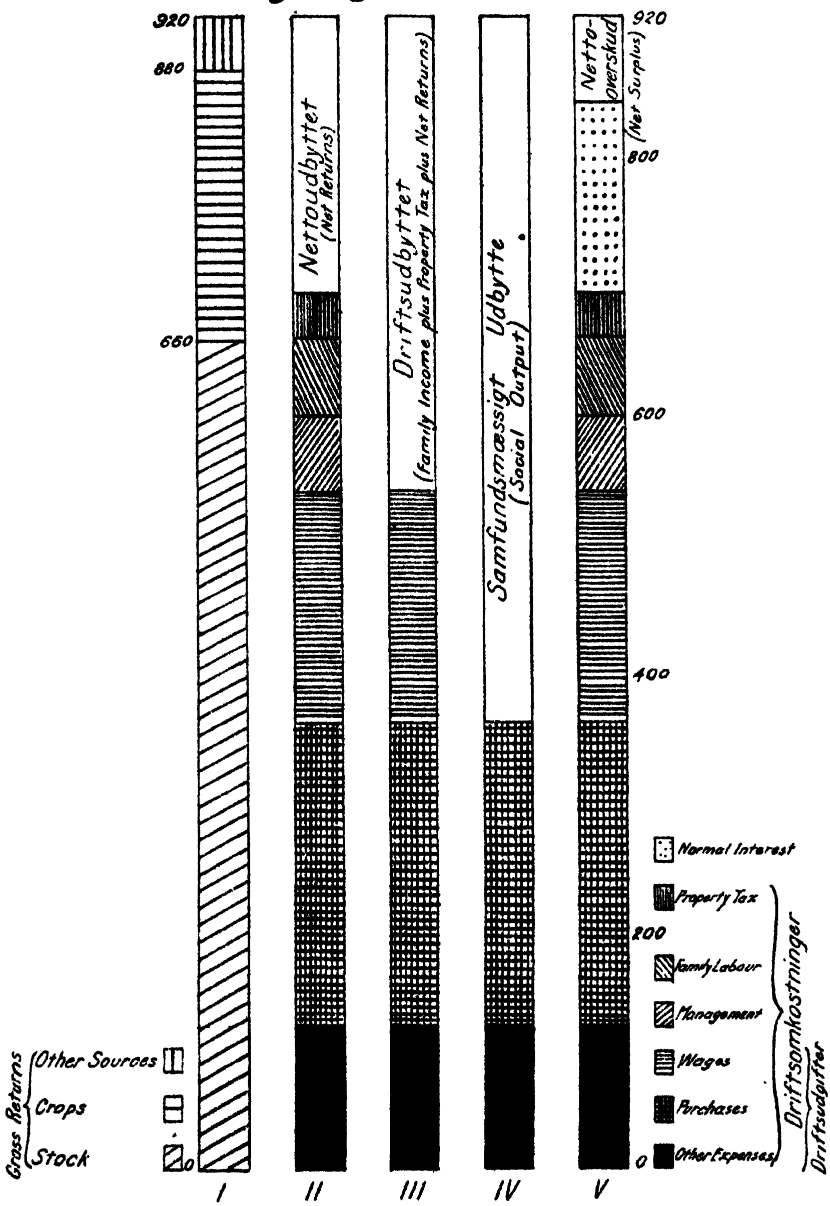
(1) Wages of labour, together with remuneration of family labour and wages of management.

(2) Property taxes to State and Commune.

(3) Net returns, or interest on capital plus net surplus.

[1] See A. W. Ashby, "Standards of Production in Agriculture," *Edinburgh Review*, January 1922.

Diagram Illustrating
Method of Analysing Farm Accounts



(The diagram is based on the average statistics of production and working expenses for the five year period 1917–22.)

In the third column the results are considered in a less impersonal way. In the majority of cases remuneration for family labour and wages of management do not represent an actual expense in the sense that they entail an outlay on the farmer's part. By deducting these charges (and strangely enough the property tax is also included in this reduction) from the theoretical conception of working expenses, a more practical conception of expenses as "Driftsudgifter" is obtained. The difference between this and the gross returns gives "Driftsudbyttet" (the unshaded part of column III.), and this is what most farmers would consider to be the more important figure. As will be seen from the diagram, it can also be obtained by deducting the wages bill from the social output, as well as by adding remuneration for family labour, wages of management, and the property tax to the net returns.

Results.—The six reports already published by the Bureau contain valuable information both on the internal economy of the farm and on the more general economy of the country's agriculture. The interest of these reports is all the greater since they deal with the critical period immediately following the Great War. Their substance formed the basis of an address by Prof. O. H. Larsen, the director of the Bureau, to the Economic Club at Copenhagen in March 1924, and this address supplies a useful summary of the work so far accomplished.[1]

The contribution to the problem of the economic unit of production is of great interest. In Table I. the results for the six years are arranged in three groups according to their area—smallholdings (under 25 acres), middle sized farms (25-124 acres), and large

TABLE I.

Results of 2195 *Danish Farms*, 1916-17—1922-23.

	Kroner per hectare.*						
	1917-18.	1918-19.	1919-20.	1920-21.	1921-22.	1922-23.	Average, 1917-23.
A. *Smallholdings* (under 10 hands).							
Agricultural Capital	2807	3256	3533	3794	3488	3281	3357
Gross Returns	744	1133	1383	1993	1247	1276	1296
Working Expenses	593	825	1095	1714	1248	1107	1097
Net Returns	151	308	288	279	1	169	199
Do. in % of Agr. Capital	5·4	9·5	8·2	7·4	0·0	5·2	5·9
B. *Middle-sized Farms* (10-50 hands).							
Agricultural Capital	2895	2907	2844	2859	2829	2477	2802
Gross Returns	713	857	1013	1145	836	829	899
Working Expenses	496	546	730	903	799	678	690
Net Returns	227	311	283	242	37	151	209
Do. in % of Agr. Capital	7·8	10·7	10·7	8·5	1·3	8·1	7·5

* 1 hectare = 2·47 acres. 1 krone (normal exchange) = 13·2d.

[1] See "De økonomiske vilkaar for Landbrug af forskellig störrelse under og efter Verdenskrigen," by Prof. O. H. Larsen.

TABLE I.—*continued.*

	Kroner per hectare.*						
	1917–18.	1918–19.	1919–20.	1920–21.	1921–22.	1922–23.	Average, 1917–23.
C. *Large Farms* (over 50 hands).							
Agricultural Capital	2584	2638	2593	2541	2488	2363	2535
Gross Returns . .	624	742	899	926	661	652	751
Working Expenses .	428	460	629	732	631	539	570
Net Returns . .	196	282	270	194	30	113	181
Do. in % of Agr. Capital . .	7·6	10·7	10·4	7·8	1·2	4·9	7·1
All Farms.							
Agricultural Capital	2824	2876	2849	2887	2808	2628	2812
Gross Returns . .	699	857	1024	1185	831	867	911
Working Expenses .	482	551	743	949	798	719	707
Net Returns . .	217	306	281	236	33	148	204
Do. in % of Agr. Capital . .	7·7	10·6	9·9	8·2	1·2	5·6	7·3

* 1 hectare = 2·47 acres. 1 krone (normal exchange) = 13·2d.

farms (over 124 acres). Group A is based on 202 accounts, Group B on 1527 accounts, and Group C on 466 accounts. Since the table is not meant for comparative purposes with this country the Danish units have been retained, and it is very important that the terms used should be interpreted in the exact meaning given them above. Some of the results already established by research work on this problem in this country[1] find ample support in the table. Thus, it clearly illustrates the inverse ratio of the degree of capitalisation, production and working expenses to the area. Unfortunately the results are not also given per person employed. The higher capital per hectare which characterises the smallholdings is particularly evident for the building, machinery and the live stock, *i.e.* it is entirely due to the greater intensity of the farming. The table shows that for the last three years the gross returns per hectare for smallholdings has been twice as large as for the bigger farms. While an examination of the gross returns itself shows the greater comparative importance of arable farming on the larger holdings, and of dairying, pigs and poultry on the smaller farms—thus during the last two years stock production makes up 85 per cent. of the total production of the small holdings, but only 50 per cent. of the production of the large farms, while for 1918-19, when stock production was at a minimum, the corresponding figures were 68 per cent. and 42 per cent. respectively. The working expenses per hectare shows a still greater difference between the three groups. What pushes up the working expenses of the smallholder is the higher interest demanded by his comparatively larger capital, his larger purchases of feeding stuffs, and his higher labour bill when personal and family labour are assessed at current

[1] See "Large and Small Holdings," by J. Pryse Howell in *Welsh Outlook*, January 1922.

rates of wages. On the contrary the difference between the three groups is not so marked for the net returns and the "forretnings-procent." Generally Group B has the highest net returns, and Group C the lowest. Group B has also the highest "forretnings-procent" and the smallholdings the lowest, but the difference here is slight and variable.

The reports also supply valuable statistics of the reconstruction of Danish agriculture following its temporary dislocation during the war. The most important influence of the war was the submarine blockade, which cut off the imports of feeding stuffs and artificial manures on which the whole structure of Danish agriculture rests. A series of bad harvests and oscillating prices resulting from the unstable exchanges were also influences at work. The sequel was a decline both in stock and crop production. Thus during 1917 and 1918 the average total crop output was only 78 per cent. of the average for the five pre-war years. Not only was the total production lower but the average yield per hectare was lower than it had been since the seventies. In this respect, however, it is important to remember the great increase that occurred in the cultivation of beets and roots, as well as in the raising of agricultural and vegetable seeds, which bids well to become an important branch of Danish agriculture. There was a correspondingly big drop in the total stock of the country. Between 1914 and 1918 the stock of milk cows was reduced by 22 per cent., pigs by 75 per cent., and poultry about 35 per cent.; an examination of the table will show how these restrictions weighed heavier on the small farms with their greater dependence on stock. It is interesting to note that the milk output had fallen 48 per cent. by 1919, although the drop in the number of cows was only about 22 per cent.—this gives the lowest average output of milk per cow since 1890. During the five years since the war, however, the stock has been gradually rebuilt, so that by 1923, with the exception of horses and sheep, it is back to normal. Indeed 1923 as compared with 1914 shows an actual increase in the production of milk products, eggs and bacon, while the crop production was also back to its pre-war level.

In the address already referred to very interesting estimates of the cost of this reconstruction are given, based partly on the official statistics and partly on the data collected by the Bureau. The cost of rebuilding the stock between 1918 and 1923 is placed at 250 million kroner; the extra consumption of artificial manures during these five years represents a value of 50 million kroner above the pre-war figure; while the purchases of new machinery and implements (completely suspended during the war) probably amounts to nearly 75 million kroner. In addition the increased running expenses resulting from the changes in the price level must be considered, since even in 1922-23 this can be put at a good 100 per cent.

AGRICULTURAL EDUCATION AND RESEARCH IN SCOTLAND.

REPORT OF DEPARTMENTAL COMMITTEE.

THE Report of the Departmental Committee appointed by the Secretary for Scotland in February last to inquire into the general organisation and finance of agricultural education and research in Scotland has now been issued, and can be obtained from His Majesty's Stationery Office, 120 George Street, Edinburgh.

The Committee consisted of Lord Constable (*Chairman*), Sir James Adam, Mr. David Black, Mr. Joseph F. Duncan, Captain Walter E. Elliot, M.P., Miss E. S. Haldane, Mr. James Keith and Dr. George Macdonald, with Mr. A. M'Callum of the Board of Agriculture for Scotland as Secretary.

The Committee held nineteen meetings in Edinburgh and heard evidence from sixty-two witnesses prominently associated with agriculture, agricultural education and agricultural research, both in this and in other countries. They consulted also various publications and reports dealing with the subject of their enquiry.

The Report gives a short summary of the development of agricultural education in Scotland from 1790 onwards, and traces the rise of teaching centres at Aberdeen, Edinburgh and Glasgow respectively. The growth in expenditure at these three collegiate centres is noted, the gradual increase in the proportion of State to local contribution being specially brought out. In this connection attention is drawn to the comparatively minor part played by Education Authorities in providing suitable preliminary courses on agricultural lines.

The existing organisation of the Colleges and their methods of working are described; the extension work in the counties is noted in some detail; and the general results of the whole system are reviewed.

The relations between the Universities and the Colleges are considered in view of a suggestion made to the Committee that all the higher scientific teaching should be left to the Universities. Suggestions are made for modifying the curricula at the Colleges, and for encouraging a certain amount of specialisation at each centre in relation to the prevailing types of agriculture in the respective areas.

Evidence pointed to the fact that the governing boards of the Colleges have grown too big and the Committee propose reconstruction of these bodies.

A section of the Report is devoted to a discussion of the problem of rural education, which, in the opinion of the Committee, is the most difficult of those reported upon. This may probably prove to be not the least interesting part of the Report inasmuch as it contains an account of the manner in which the problem has been dealt with in England, Ireland, Sweden, Denmark, and the United States. The province of the rural school in the training of the young agriculturist is indicated as preliminary natural science teaching to be given by the day school teacher, this to be followed by more advanced science teaching in the secondary school or in the

continuation class. Thereafter, the strictly technical agricultural instruction is recommended to be given by specially trained teachers who have taken an agricultural course. This last stage hinges mainly on the personality, the training, and the equipment of the County agricultural organiser, whose qualifications are discussed and whose importance in the scheme is strongly emphasised. An urgent plea is made for co-operation and co-ordination of work as between the local Education Authorities and the Colleges. As a means of co-ordination the Committee suggests the creation of joint advisory bodies in each county to whom the organisation of local agricultural education would be referred; and the provision of County demonstration areas is regarded as an essential.

An experiment is recommended to be made in instituting one or two residential schools for the giving of short courses to farmers' sons on the lines of the inexpensive models in Denmark, Norway, and Sweden. Special training in women's work on the farm is also recommended, and the value of the work of Women's Rural Institutes in this connection is recognised.

More co-operation and consultation among the Colleges is desiderated and a standing committee for this purpose is suggested.

The relative advantages of the work of the Colleges being administered by the Board of Agriculture or by the Scottish Education Department are discussed at length, and careful consideration is given to the question of the future maintenance of the Colleges from local and from State funds.

The importance of agricultural research is strongly emphasised. A short account of the existing agencies is given, and suggestions are made for their development and for additional establishments to overtake research work not yet provided for.

Veterinary education is dealt with, and the vexed question of whether there should be two colleges in Scotland is fully considered.

The recommendations made are summarised as under:—

WITH REGARD TO AGRICULTURAL EDUCATION.

1. The supervision of the Colleges should remain with the Board of Agriculture.
2. The governing bodies of the College should be reduced to 25 members, consisting of representives of local Education Authorities, agricultural interests, and higher educational institutions, together with certain co-opted members.
3. Close relations should be maintained between the Colleges and the Universities, including joint contribution to the teaching necessary for degrees in agriculture, and reciprocal representation on the respective Boards of Studies.
4. In the curricula of study more emphasis should be laid on agricultural economics and farm management.
5. Each College should endeavour to specialise in the type of agriculture prevalent within its area.
6. The course of instruction within the Colleges should be altered in such a way as more effectively to meet the needs and to attract the attendance of the ordinary farmer

   (1) by substituting for the present three years' diploma

course a shorter and more practical course extending over not more than two years;

(2) by providing short special courses on selected subjects appropriate to the types of farming in the areas.

7. A Standing Committee, representative of the Governors and Staffs of the three Colleges, should be constituted and should meet at regular intervals for the discussion of educational policy, the co-ordination of work, particularly in field experiments, and the publication of results.

8. The Governors should appoint an efficient Committee in each County to supervise the College Extension Work, and should themselves make a special effort to secure the interest of local agriculturists and Agricultural Associations therein.

9. A special official should be appointed to supervise the whole of the County Extension Work of each College.

10. More effectual means should be taken to test the qualifications of County Organisers, and in particular their qualifications as teachers and practical advisers.

11. The claim of the College Staffs for revision of salaries, and also that of the Extension Staffs for inclusion in a superannuation scheme, should be favourably considered.

12. For the purpose of co-ordinating the educational work of the College Organiser with the agricultural instruction to be provided by Education Authorities in rural schools and continuation classes, an Advisory Committee should be formed in each county, appointed one half by the College from the Committee referred to in paragraph 8, and one half by the Education Authority.

13. In considering the schemes now being submitted for Advanced Divisions, the Education Department should see that natural and agricultural science for boys and domestic and rural economy for girls receive their fair share of attention in rural schools, and they should also impress upon rural authorities the necessity for establishing agricultural continuation classes, staffed by appropriately qualified teachers.

14. So far as may be consistent with these objects, it is desirable to foster the rural school, and undesirable to concentrate country children in urban schools.

15. When centres of local agricultural education are established in county areas, it would be desirable to institute in connection therewith short special courses of lectures by members of the College staff.

16. However completely local Education Authorities may assume the duty of providing local agricultural education, the Colleges should maintain their local connection with the agricultural community through the medium of their advisory officers and county organisers.

17. There should be established by way of experiment, in a suitable locality, a residential farm school, on the plain

and inexpensive model of such institutions on the Continent.

18. A fixed proportional contribution from other sources should be laid down as the basis on which all State assistance, or at any rate any increase of the present State assistance, is made to the Colleges.

19. As one means to this end, the fees imposed at the various Colleges should be made more commensurate with the cost of instruction provided, and Education Authorities should be careful to see that no young person who is qualified for attendance at the Colleges "shall be debarred therefrom by reason of the expense involved."

20. The system of detailed examination of the accounts of the Colleges now enforced, in addition to prior approval of estimates and limitation of the total amounts of the expenditure, is conducted on unnecessarily strict lines, and ought to be relaxed.

WITH REGARD TO RESEARCH.

21. There is urgent need for an all-round development of agricultural research in Scotland.

22. In particular, the Institute for Research in Animal Diseases is very inadequately staffed to deal with numerous and important problems which require investigation, and should be materially strengthened.

23. The Plant Breeding Station is also inadequately staffed, and should be more generously treated.

24. The Rowett Research Institute should be provided with an experimental and demonstration farm.

25. A Research Institute should be established in connection with the National Dairy School at Kilmarnock.

26. The systematic recording and analysis of data necessary for agricultural costings should be resumed and extended.

27. Provision should be made for special research in plant pests and diseases.

28. The possibility of raising special funds for agricultural research should be more fully examined, and, in particular, careful consideration should be given to the suggestion for a limited rate on agricultural land.

WITH REGARD TO THE VETERINARY COLLEGES.

29. The maintenance of two Veterinary Colleges in Scotland is from a purely educational point of view unnecessary, and, in view of the relative circumstances of the two existing Colleges, the grant of State assistance to the Glasgow College should be discontinued.

30. The affiliation of the Royal Dick Veterinary College to the University of Edinburgh is desirable, alike in the interests of the College and the veterinary profession.

THE BIOLOGIST ON THE FARM.—No. XV.

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The Bee Dance.—When an exploring bee discovers some flowers with abundant nectar, it takes in as much as it can hold and makes for home. In a short time there are more bees on the scene. How do they know that there is treasure trove and how do they find it? Very careful experiments by Professor Karl von Frisch have thrown light on this. When a bee that has sucked to the full returns to the hive, it indulges in a peculiar "round dance" on the comb. This excites the workers in the immediate vicinity and they hurry forth to find some nectar for themselves. But before issuing from the hive they nose at the discoverer, and thus get an olfactory clue to the kind of flower to be sought after. The discoverer does not fly with them, that is certain. They explore for themselves. But they have got the scent as a clue.

But what if the nectariferous flower has no scent? Frisch's answer is that a hive-bee, excited by a discovery, sprays the blossom with a characteristic scent formed in a protrusible glandular pocket near the hind end of her body. This scent serves as a tell-tale clue to the searching bees.

It has been noticed that when a profitable patch of flowers begins to be exhausted, the visits of "new bees" begin to drop off. In a short time they stop. How is this regulated? The answer is that when a bee returns with little nectar she does not dance; and thus no more searchers go forth. When the bees are collecting pollen, not nectar, there is the same sort of "dance language," but the nature of the dance is different!

Eelworms coming Alive again.—The threadworm, *Tylenchus tritici*, that causes "ear cockles" in wheat, is famous for its power of surviving prolonged desiccation. In its brown or purple galls which replace the grains of corn there are hundreds of motionless larvæ, the progeny of a pair. They can remain for a long time inert, yet not dead. When the galls are soaked in water for some hours they swell up and liberate a creamy substance, which is made up of crowds of minute larvæ. They can wriggle and they can swim, and the importance of this is that they can reach and infect wheat seedlings if galls have been sown along with the healthy seed. The question recently re-investigated by Dr. T. Goodey is how long the desiccation may last without being fatal. Needham sent some galls to Baker in 1744 and it was belived that revival took place in 1771. It seems, however, that no proof of the vitality of the larvæ was given. No mention is made of their movements. It is of much interest, therefore, to note that in Dr. Goodey's recent experiments with the wheat eelworm the maximum period of non-fatal desiccation was nine years. In an allied species, *Tylenchus dipsaci*, found in diseased onions and narcissus bulbs, the almost mature larvæ revived after being kept dry for two years and two and a quarter years respectively. The period of possible reviviscence or coming alive again probably

varies according to conditions, and more experiments should be made, for the state of latent life deserves more penetrating study.

Internal Defences of the Body.—Many diseases, as everyone knows, are due to virulent microbes which find their way into the body and run riot there, it may be in the food-canal, or in the blood, or in various tissues. These microbes are usually Bacteria —inclined to the Plant Kingdom, as in the case of tubercle, small-pox, plague. But the disease-causers may be microscopic animals, as in the case of malaria, syphilis, and sleeping sickness. In cases like "foot-and-mouth disease," where the demonstration of a microbe seems still uncertain, it is wise to speak of an ultra-microscopic or filterable "virus"; but the probability is that here also we have to do with a living organism that invades the body.

Opposing the hostile microbes there are outer ramparts, notably the skin; hence the danger of little wounds, which are like breaches in the walls and allow the beleaguering enemies to find entrance. There are also inner ramparts such as the digestive wall of the food-canal and the lining membrane of other internal surfaces, such as the lungs. If these ramparts are broken down, and the assailants get into the city, which is the body, then there is fighting in the streets and things become very serious both for man and beast. The assailants produce deadly poisons, and they are also able to break down important tissues, making gaps or lesions. An invisible microbe, which may be seen magnified inside the letter "o" of this word, may be the progenitor of a million in twenty-four hours. A cat may look at a king, but a microbe could soon kill a mammoth if there were any to kill. The tragedy is very familiar, but it never loses poignancy; a fine organism—whether man or beast—brought to the dust in a few days or even hours by a contemptible invisible microbe!

Two of the internal defences of the body are well known. The blood is able to produce antitoxins which baulk the toxins of the microbes. Set a thief to catch a thief; one secretion checkmates another secretion. Roux and Yersin demonstrated the toxins produced by bacteria; Behring and Kitasato proved the importance of the antitoxins which are the organism's answers back; Roux and Martin showed how antitoxins may be produced by mild infection in an animal and kept in readiness to be injected into another animal when that is infected, or when the risk of its infection is great. Antitoxins have not been isolated as yet, and we must not be too sure that they are definite substances that *can* be isolated. It may be that they are merely properties or qualities of the colloidal equilibrium of the blood. Theories abound, but no one is sure—or rather no three people are agreed—as to how antitoxins work against the toxins. It must be in some complex, physico-chemical fashion.

The second internal defence is on the part of phagocytes—wandering amœboid cells of good appetite which engulf and digest virulent intruders. They are found in almost all animals, from sponges to man, and in backboned animals they represent particular kinds of white blood corpuscles which are able, if need be, to leave the vessels and pass into surrounding tissue. Whenever there is any inflammation, that means that a struggle is going on between

the bodyguard of phagocytes and the assailant microbes. The phagocytes belong to the body and they have other functions besides engulfing bacteria; thus they may help in replacing a part that has been lost, or in a great change of structure like that which occurs between a maggot and a fly. In the conflict between phagocytes and bacteria the issue is sometimes affected by the production of "opsonins," which seem to paralyse the bacteria so that they become more readily the prey of the phagocytes. Some say that the opsonins whet the appetite of the phagocytes. Opsonins have not been isolated, and it may be that they merely represent a particular aspect of the work of antitoxins.

It is understood, then, that if one of our domesticated animals or one of ourselves be attacked by a virulent microbe, the issue depends on the formation of antitoxins by the blood and on the activity of phagocytes.

A good-going Heresy.—A heresy that is not "cranky" should always be welcomed. It upsets our easygoingness and makes for progress. So we wish to refer to Dr. D'Herelle's heresy of the "Bacteriophage" or "bacterium-destroyer." Dr. D'Herelle is one of the distinguished bacteriologists of the Pasteur Institute, and he has been studying for some years what he calls the Bacteriophage —an organism that lives as a partner in the food-canal of many different kinds of animals, and is important inasmuch as it becomes a fatal parasite in various kinds of virulent bacteria and destroys them. There seems to be only one species—*Bacteriophagum intestinale* D'Herelle, but it can develop an appetite for a good many kinds of disease-producing bacteria.

When some of the debris from a patient suffering from dysentery is thoroughly filtered, through a porcelain filter which will not allow of the passage of ordinary bacteria, a limpid fluid is obtained which shows *nothing* under the microscope. Indirectly, by means of ultra-microscope, it seems possible to demonstrate corpuscles, ten times smaller than the smallest microscopically visible bacteria, and these are the bacteriophages. Something there must be, for a little of the filtrate added to a culture of dysenteric bacteria brings about their rapid dissolution. This bacterium-dissolving power can be continued indefinitely, as long as there are bacteria to dissolve. It is not lessened by dilution. It can be introduced with advantage into the food canal of another organism. D'Herelle believes that a bacteriophage penetrates a bacterium, and multiplies into 10 or 15 extremely minute units, which feed at the bacterium's expense. Furthermore the surplus products of bacterium solution are useful in paralysing the bacteria and "educating" the phagocytes. Of course the bacteria do not always give in to the bacteriophages. It must be noted that according to some critics, D'Herelle's bacteriophage is simply a name for an aspect of an antitoxin; but he argues his case well and pleasantly. In any case there are facts to be interpreted, whether *Bacteriophagum intestinale* is a genuine living organism or not. If D'Herelle is right, things are even more complicated than was supposed; instead of there being merely a conflict between invading microbe and the organism invaded, which brings forward its antitoxins and phagocytes, there is a three-cornered fight

between microbe, organism and bacteriophage. For the bacteriophages do not belong to the organism as the phagocytes do; they represent a partnership. If D'Herelle is right, some practical applications will follow. If bacteriophages are our friends, can we have too many of them? Should we not add some to our draught of water, or to the horse's?

Birds and the Farmer.—Dr. James Ritchie is dealing with this question in his unsurpassably careful way; we wish merely to refer to two sights we saw in September. One was a crofter's field of oats, from which as we passed there rose a dense cloud of sparrows. They settled down on some rowan trees near by, chattering in their usual self-complacency. But the field was lamentable. As far as we could see clearly the ears were more like chaff than grain. It looked as if the field had been thrashed. We are strongly persuaded that only a few species of birds do much harm; but sparrows often become a scourge. The crofter is of more value than many sparrows.

The other sight that rather alarmed us was a splendid field of wheat in stooks. But perched on the stooks there were dozens of herring-gulls gorging themselves with corn. We should think that there were at the very least two hundred herring-gulls in that field; and they have big appetites. In a comparatively small number of years the herring-gull has become more and more of a crop-eater, and when we add to the corn-eating in summer the turnip-eating in winter there is very serious loss. We have noticed that gulls of several species are very averse to nets, and we wondered if it would not pay to cover each stook with a piece of old herring-net supported by four light stakes. But perhaps we are under-estimating the quantity of netting that would be required, and the amount of labour involved.

Growth.—Many biologists have tried to sum up the characteristics of living creatures, and the summations differ very considerably. But all are agreed in giving a prominent place to the power of growth. Living creatures have a fundamental capacity for adding to the amount of their living matter. The egg of a frog is rather under a tenth of an inch in diameter; the frog's body is about four inches long. That means a very considerable increase in the amount of living matter; and while a crystal can grow only at the expense of a solution of the same chemical composition as itself (or of the same crystalline form), a living creature usually grows at the expense of something very different from itself. They say that a single microbe may be represented at the end of twenty-four hours by a progeny requiring thirty figures for its enumeration; and before each of the rapidly succeeding divisions into two there is a short period of rapid growth.

We ought to know more about growth than we do, not only for the sake of intellectual clearness, but also for practical purposes. Behind all agriculture and stock-rearing there is growth. So we wish to recommend strongly a luminous and not too technical book, G. R. de Beer's *Growth* (Arnold, London, 1924). It seeks to show what growth is, what it does and how it does it; it is full of fresh facts that deserve to be well known.

One of the interesting facts that recent work has emphasised is

the control that one part of the growing body exerts on another, for growth is a delicately regulated process. Sometimes it runs riot and giants result, but usually it is controlled with some strictness. In the majority of animals there is a very definite limit of growth. In the little flat worms or Planarians that are common in some brooks, the head end, which is the most intensely living part of the body, exerts a controlling influence on the part of the body behind it. But as the worm grows larger and the posterior part is shoved out to a greater distance from the head end, the controlling influence of the head is correspondingly reduced. Then an interesting self-assertion takes place on the part of the posterior body, which eventuates in its separating off as a new individual. This throws a clear beam of light on various processes of asexual multiplication, whether by dividing into two or by giving off buds. De Beer gives many interesting examples of the regulatedness of growth.

The Growing Point.—One of the distinctive features of plants as contrasted with animals is the presence of "growing points," familiar to us at the tips of shoots and roots. They remain always young and growing, adding to the structure of the plant as long as it lives. At the tip of a fern stem there is one large cell which divides continuously. At the tip of a flowering plant's shoot there is a dome of embryonic cells. On the sides of the dome there are little swellings—the leaves that are to be; and in the axils of the young leaves there may be seen the beginnings of buds—the future shoots.

Now the buds that are formed in the leaf-axils (the angles between the leaves and the stem) are, in some way or other, prevented from developing by the influence of the growing point. "It is only when the growing point has got a sufficient distance away from any bud that it will develop. This can be tested experimentally, for if the growing point be rendered inert by covering it with a cap of gypsum the buds beneath it will develop. The same result is obtained when the growing point is killed. If, however, the gypsum cap be removed, the growing point will resume its growth, and the shoots which have developed from the buds during its enforced quiescence will *die*." The growing point is a tyrant which suppresses as long as it can the powers of the growing points of the minor shoots. Its influence is something like that of the head end of the Planarian worm, which dominates the region behind it. This is not a season for studying growing points; but we may look at them with a fresh eye in spring. And there are discoveries to be made even in the growing point of a wallflower.

Have Plants any Hormones?—In backboned animals the regulation of growth is partly due to the hormones or "chemical messengers" which the ductless glands secrete into the blood. In its circulation they are swept through the body, like Yale keys seeking their appropriate locks, some to open and some to shut. It has been proved experimentally that one of the functions of the hormones secreted by the pituitary body, which hangs down below the brain, is to regulate growth. Pathological dwarfs and giants imply something agley with their pituitary body. In backboneless

animals we do not know of more than two or three indications of hormones; but we venture to prophesy that they will be found to be common. The question rises whether they exist among plants. We should not, indeed, expect conspicuous evidence of growth-*restricting* hormones, for many plants, like the "Big Trees," have great capacity for growing on and on.

If we take a leaf of the common broad-leaved Plantago from the roadside and break the stalk across, we see a number of strands like pieces of string. These are the fibro-vascular bundles, made up of woody-tissue and bast, with a zone of embryonic tissue (or cambium) between. In all plants that have true stems—say from ferns to flowering plants—there are these bundles; and the only growing tissue is in the cambium of these separate bundles. But the separate strips of cambium (or growing tissue) are united into a growth-ring or growth-cylinder by some influence which the bundle-cambium exerts on the intervening tissue. "This activation of the intervening regions suggests the effect of a hormone, and there is evidence that one is produced in the bast of the vascular bundles (probably in the companion cells to the sieve-tubes)."

What has this to do with the farm? Much, and in more ways than one. Let one way suffice. As the farmer well knows, there is no use planting a big slice of potato if it has not an "eye" or bud. But this statement may be made more precise: small portions of isolated tissue of potato will not grow unless some bast be present. This indicates that a hormone is present in the bast.

THE SELF-FEEDER FOR CALVES.

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IN the feeding of farm animals the conditions prevailing are to a large extent artificial and the role played by appetite in the selection of foods is not, as a rule, large. It is undoubtedly true, however, that appetite is an indicator of the physiological needs of an animal, as where animals are fed by the free-choice method, appetite controls their ration to a considerable degree. The use of the self-feeder has become quite common in recent years in the raising and fattening of pigs, but in the feeding of other types of live stock, especially dairy cattle, it has been utilized to but a limited extent.

The present trial was undertaken with a view to determining the palatability of some common feeds to young dairy calves, and to ascertaining the practicability of using the self-feeder in calf-raising. The work is but the start of a series of trials and must be looked upon as preliminary.

Resumé of Previous Work.—Only a limited amount of attention has been given to the study of appetite, though Evvard (3) has reviewed the literature on the subject and shown that appetite is a fairly reliable indicator of the physiological needs of the pig. Material which has been obtained for other purposes than that of an appetite study may be reviewed in connection with the work reported here on the grinding of grains for calves.

It was stated by Jordan (8) that the grinding of oats and

maize increased their digestibility in the case of horses, though with sheep whole oats were as completely utilized as the ground grain. In a trial with supplements to skim milk for calves, Fain and Jarnagin (4) found that the consumption of whole maize was greater than that of maize meal, while the rate of live weight gain was greater and the amount of grain consumed per pound of live weight gain was less in the case of the lot fed whole maize. Otis (15) found that calves fed whole maize made larger gains and consumed less skim milk and hay, though slightly more grain, per pound live weight gain than did those fed the crushed grain. It was reported by Hanly (5) that young calves preferred whole grains, and Kildee (9) also recommended whole oats, while Woll and Voorhies (16) found a slight advantage in feeding ground grain, though the difference was not sufficient to pay for grinding.

It was found by M'Candlish (10, 11, 12) that young calves preferred whole oats and maize to the ground grains, though after weaning cracked maize seemed to be preferred to the whole grain, and that they ate more linseed meal than bran. He found that there was little difference in the feed cost of raising dairy heifers to two years of age by the self-feeder method or by hand feeding when a liberal grain allowance was given, but the feed cost per pound of live weight gain was lower with the self-fed lot.

In connection with the use of the self-feeder, Cook (2), Nevens (14) and M'Candlish (13) reported good results where a grain mixture was provided in a self-feeder for calves, though after self-feeding beef calves Bohstedt (1) wrote that it was not the most satisfactory practice. The only report on the self-feeding of milk cows is from Hunt (7), who found that they consumed so much grain that milk production was very uneconomical.

Experimental Work.—For this trial five heifer calves by a Friesian bull and out of grade Ayrshire cows were used. Calves No. 81 and 82 were twins. Information concerning the animals has been tabulated, and where necessary it has been calculated to the date on which the experiment started, 1st February 1924. The average age of the calves at the beginning of the trial was 11 days and they had an average live weight of 72 pounds. Their sole ration previous to the start of the experiment was whole milk.

TABLE I.

Animals Used.

Calf No.	79	80	81	82	83	Average.
Age in Days	15	12	11	11	8	11
Weight in Lbs.	76	74	66	68	79	72

The trial lasted for three consecutive periods of thirty days each and the calves were weighed at the beginning of the trial and at the end of each period. At the beginning whole milk was fed to all calves according to their capacity and towards the end of the first period each was receiving 15 pounds per day, and this amount was kept constant until the end of the trial.

Good mixed lea hay was kept before the calves at all times and

a self-feeder of six compartments kept them constantly supplied with concentrates. The concentrates provided were whole maize, maize meal, whole oats, ground oats, linseed cake and wheat bran. The feeds were weighed in as required, so that there would be no opportunity of their becoming stale, and at the end of each thirty-day period any feed left was weighed. A record of the hay consumption was also kept. A salt brick was provided for the calves and was dried and weighed at the end of each period. The calves had daily access to water, but no record of the amount consumed was obtained. The experimental animals were in a light, airy loose-box and so had plenty of room for exercise, and as they were not tied at any time they always had access to the feeds.

Results obtained.—In discussing the results the feed consumption will be first considered. The total feed consumption for the group has been tabulated by periods and the average daily consumption per calf calculated

TABLE II.

Total Feed Consumption.

Period No.	Whole Milk.	Mixed Hay.	Whole Maize.	Maize Meal.	Whole Oats.	Ground Oats.	Linseed Cake.	Wheat Bran.	Total Concentrates.	Salt.
	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Oz.
I.	1955	24·5	24·8	5·6	8·6	1·5	8·3	1·3	50·1	5
II.	2250	65·3	85·8	29·5	43·0	1·8	32·8	17·3	210·2	5
III.	2250	68·5	208·0	62·5	44·5	22·5	74·8	36·5	448·8	5
Total	6455	158·3	318·6	97·6	96·1	25·8	115·9	55·1	709·1	15

TABLE III.

Average Daily Feed per Calf.

Period No.	Whole Milk.	Mixed Hay.	Whole Maize.	Maize Meal.	Whole Oats.	Ground Oats.	Linseed Cake.	Wheat Bran.	Total Concentrates.	Salt.
	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Oz.
I.	13·0	·16	·17	·04	·06	·01	·06	·01	·33	·033
II.	15·0	·44	·57	·20	·29	·01	·22	·12	1·40	·033
III.	15·0	·46	1·39	·42	·29	·15	·50	·24	2·99	·033
Average	14·3	·35	·71	·22	·21	·06	·26	·12	1·58	·033

TABLE IV.

Consumption of Whole and Ground Grains.

Period No.	Whole Grains.			Ground Grains.			Whole Grain per lb. of Ground Grain.
	Maize.	Oats.	Total.	Maize.	Oats.	Total.	
	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.
I.	24·8	8·6	33·4	5·6	1·5	7·1	4·7
II.	85·8	43·0	128·8	29·5	1·8	31·3	4·1
III.	208·0	44·5	252·5	62·5	22·5	85·0	3·0
Total	318·6	96·1	414·7	97·6	25·8	123·4	3·4

The consumption of concentrates is large, going up from ·33 pounds per head per day in the first period, to 2·99 pounds in the

third, and averaging 1·58 pounds. The hay consumption also increased considerably, but at a much lower rate than the grain consumption. The salt consumption was constant.

The calves showed a marked preference for some of the concentrates over the others. Whole maize was first favourite throughout, and when the total consumption during the trial is considered the other feeds came in the following order:—linseed cake, maize meal, whole oats, wheat bran and ground oats. These relative positions were kept fairly well throughout the trial with the exception that whole oats, linseed cake and maize meal ranked second, third and fourth in popularity during the first and second periods, while bran and ground oats changed places in the first period. The changes that took place in the relative rankings of the feeds were due largely to the greatly increased consumption of maize meal in the third period and of linseed cake and wheat bran after the first period. During the third period the consumption of ground oats increased considerably, but yet not enough to bring it out of last place.

In the first period the ratio of ground to whole grain consumed, considering maize and oats together, was 1 : 4·7, and this ratio gradually narrowed to 1 : 3·0 in the third period. This shows that the calves exhibited a marked preference for the whole grains, though as they became older they did consume relatively greater amounts of the ground grains than they did earlier. At no time during the trial was there any indication of whole grain passing through the calves.

TABLE V.

Live Weight Gains.

Calf No.	79	80	81	82	88	Total.	Average.	Average Daily Gain.	
								Per Period.	Cumulative.
Weighing	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.
Initial	76	74	66	68	79	363	72·6	...	...
Period I.	124	122	112	113	127	598	119·6	1·57	1·57
Period II.	177	176	161	170	179	863	172·6	1·77	1·67
Period III.	234	234	219	227	233	1147	229·4	1·89	1·74

The calves gained regularly and well, the average daily gains varying from 1·57 pounds per head during the first thirty days, to 1·89 pounds in the last period, and averaging 1·74 pounds. The calves were in forward condition at the beginning of the trial and at the finish were extremely good.

TABLE VI.

Feed Consumed Per Pound Live Weight Gain.

Period No.	Whole Milk.	Mixed Hay.	Concentrates.
	Lbs.	Lbs.	Lbs.
I.	8·32	·10	·21
II.	8·49	·25	·79
III.	7·92	·24	1·58
Average	8·23	·20	·90

TABLE VII.

Actual and Expected Consumption of Nutrients.

Nutrients.	Total.		Per 1000 lbs. Live Weight.		Increase over Standard.
	Required.	Consumed.	Required.	Consumed.	
	Lbs.	Lbs.	Lbs.	Lbs.	Per cent.
Total Dry Matter	1379	1658	20·7	24·6	20
Digestible.					
Crude Protein	220	307	3·3	4·6	40
Carbohydrate Equivalent	926	1488	13·9	22·4	61
Nutritive Ratio	...	...	1 : 4·2	1 : 4·9	...

On the average the calves used 8·23 pounds of milk, ·20 pounds of hay and ·90 pounds of concentrates for producing one pound of live weight gain. The requirements of grain increased rapidly throughout the trial. The variations in the requirements for the other constituents of the ration were neither so uniform nor so marked — largely on account of the great increase in grain consumption.

The total nutrients consumed by the calves have been worked out from the averages given by Henry and Morrison (6) and have been compared with the requirements set forth at the same source. The calves consumed much greater quantities of nutrients than are called for by the feeding standard, the increase ranging from 20 per cent. in the total dry matter and 40 per cent. in digestible crude protein to 61 per cent. in digestible carbohydrate equivalent. This very large increase in the consumption of digestible carbohydrate equivalent widened the nutritive ratio of the ration of the calves to 1 : 4·9 as compared with 1 : 4·2 as called for by the feeding standard.

TABLE VIII.

Prices of Feeds.

Feed.	Price.
	£ s. d.
Milk	0 0 9 per Gallon
Maize	10 0 0 per Ton
Maize Meal	10 10 0 „
Oats	10 0 0 „
Ground Oats	10 10 0 „
Linseed Cake	13 0 0 „
Wheat Bran	8 10 0 „
Mixed Hay	5 0 0 „

When the costs of the feeds are taken at commercial rates it is found that the cost of the milk constitutes 87 per cent. of the feed cost of rearing the calves, the concentrates 12 per cent. and the hay 1 per cent. The feed cost per head during the three months of the trial was £5, 11s. 6d. The feed cost per calf per day was

14·9 pence, while the feed cost per hundred pounds live weight gain worked out at £3, 11s. 3d.

TABLE IX.

Feed Cost of Production.

Feed.	Cost per Calf.	Cost per Calf per Day.	Cost per 100 lbs. Gain.	Percentage of Total Cost.
	£ s. d.	d.	£ s. d.	Per Cent.
Milk	4 16 10	12·9	3 1 9	87
Concentrates . . .	0 13 3	1·8	0 8 5	12
Hay	0 1 5	·2	0 0 11	1
Total . .	5 11 6	14·9	3 11 3	100

Summary.—As a result of this preliminary trial the following statements may perhaps be made:—

1. Young dairy calves can be successfully raised when concentrates are self-fed.
2. The cost of raising calves with a self-feeder is perhaps high, though the live weight gains are not so expensive as would at first appear.
3. Calves can be kept in exceptional condition by this method of feeding.
4. Whole maize and oats are preferred to the ground grains.
5. Linseed cake is very palatable to calves.
6. Wheat bran and ground oats were consumed in relatively small amounts.
7. In palatability the concentrates used were in the following order:—whole maize, linseed cake, maize meal, whole oats, wheat bran and ground oats.
8. The calves appeared to consume salt regularly.

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THE DOG AS CARRIER OF DISEASE TO DOMESTIC ANIMALS.

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EVERY farmer knows of the admirable and useful qualities of the dog, and there is no need to dwell on the sagacity which makes him so valuable as a servant, and the sociability which renders him so esteemed as a friend. His capacity for spreading disease to the other animals on the farm is less well known, and it is the purpose of this article to indicate the risks run in this respect in Scotland.

The damage done by the "sheep-killing" dog is fully appreciated by the farmer; so also is the loss due to the chasing of stock by uncontrolled and irresponsible animals, and it is not proposed to dwell on that aspect at length. Rather we wish to review the less obvious but much more expensive indirect harm done by the dog.

Rabies.—The disease known as Rabies is, in the main, a disease of dogs, and although it was present in Britain in the days immediately after the war, it has now been definitely stamped out. The infective agent is too minute to be seen under the highest powers of our microscopes and is in consequence called an "ultra visible virus." This virus is found in the saliva of rabid animals and is spread by wounds in the skin becoming infected with such saliva. Wounds need not necessarily be made by the dog, as he can transmit the disease to his master by merely licking his hand, provided of course that there is some abrasion of the skin. The virus will not pass through absolutely sound skin. All the domestic animals may suffer from rabies, generally through the bite of a "mad" dog, although other members of the dog family may be equally responsible. It must be remembered that many diseases of the dog cause symptoms only distinguishable from Rabies with considerable difficulty; and that the bite from a dog, unless actually infected with the disease, will not cause Rabies. Among other causes of symptoms simulating this disease in dogs are infestations with Round and Tape worms, infections with Tongue worms, and certain digestive diseases, besides, of course, various nervous disorders.

Anthrax.—Anthrax is primarily a disease of cattle and sheep, but all of the domestic mammals—as well as man—may be

affected. The cause of the disease is a small organism which, when out of the body, forms a small resistant spore. These spores may live for a long time in soil or litter and if ultimately swallowed may cause a fresh outbreak. The dog in his well known role of scavenger is not only capable of infecting himself by coming in contact with an animal dead from the disease, but he may disseminate the spores throughout a large area. That is one reason why it is so important to isolate entirely any ox which dies suddenly and why burning of an Anthrax carcase is so desirable. Dogs at all costs must be kept away from it and the spot where it had lain prior to burning or burial.

Foot and Mouth Disease.—Another disease which dogs may acquire is "Foot and Mouth" disease. Like man, dogs seem to be infected through drinking milk from cattle suffering from the disease; and, as in man, the disease is seldom severe. The very fact that it is mild, however, increases the danger of the virus being indiscriminately spread throughout the district. Moreover in all probability the dog may carry the infection on his paws. The fox, and indeed all wild mammals (including rats), are probably also capable of conveying the virus from one place to another. It has been shown in America that dogs have actually carried the disease in this manner from an infected to a clean area.

Tuberculosis.—Tuberculosis is another disease to which the dog in common with most other animals is subject; but it is improbable that he plays much part in the dissemination of the disease among cattle. The dog is more dangerous where children are concerned, as he seems to acquire the bacillus in most cases from human sources. The human strain of the organism is of course less dangerous to stock than tuberculosis of bovine origin.

Parasitic Diseases.—The parasitic diseases of the dog, particularly those caused by Tape-worms, are of considerable danger to other animals.

Hydatid.—This condition is caused by the larval stage of a very small Tape-worm found in the dog, fox, cat and possibly other carnivorous animals. It is less serious in the domestic animals than in man solely on account of the slow growth of the parasite and the relatively short life of the host. The adult worm is very small—about half an inch long—and consists of only three or four segments and a head. The head is similar to that of other tape-worms, but smaller; the first segment is immature; the second contains the mature genital organs; while the remaining one or two are almost completely filled with the small eggs. Segments containing eggs are passed with the fæces of the dog and become scattered over a wide area. The segments gradually disintegrate and the eggs reach the grass, vegetables or water. In this way they are swallowed by the animal which is to act as the intermediate host to the parasite. (This part of the life history is identical with all the related Tænias.) The eggs hatch in the digestive tract of this animal—man or any of the domestic mammals—and the small larva, migrating to the blood stream, is carried to the liver or, less frequently, the lungs. Here it proceeds to develop into a Bladder-worm. It differs from the "Gid" Bladder-worm or Cœnurus in that the original cyst gives rise to

numerous "Brood-capsules," each of which is a miniature cyst containing many small Tape-worm heads. Each head in the Hydatid on being swallowed by a dog will become an adult Tape-worm. That is why an infection with *Echinococcus granulosus* in dogs is generally very heavy.

The disease is an insidious one and many years elapse before the cyst is mature. Daughter and grand-daughter cysts, budding off from the parent cyst, may migrate to other organs and there set up a new focus of infection. The symptoms in the domestic animals are vague, if indeed any are seen. This is probably partly because of the great adaptability of animals to any slowly changing structure, and partly because of the early slaughter of food animals. In man the disease is extremely serious.

If the definitive host (*i.e.* the host in which the adult occurs) is allowed to remain at large, even the most careful is liable to be infected through contamination of food such as vegetables and water. The disease is by no means unknown in Britain. In all the domestic animals, especially in the pig, sheep, ox and horse, it is fairly common—although only found on post-mortem examination in an otherwise healthy carcase. The writer has seen in Scotland an apparently healthy fat ox, the liver of which was many times its normal size on account of the Hydatid cysts present. The loss to the farmer is not great, consisting only of the condemned infected offal; but he has a very responsible duty to see that such offal is destroyed and not fed to dogs or foxes, and so to prevent the further incidence of the disease in man.

It is curious that although Hydatid is common the adult parasite is but rarely seen. In fact, the writer has only seen two cases in Scottish dogs. A possible explanation is suggested by the recent discovery of the worm in British foxes. These may possibly be the most important culprits. It accordingly behoves the farmer to be even more strict in the disposal of infected organs.

Gid, Sturdy, or Staggers.—This disease, like Hydatid, is due to the presence of a parasitic cyst. The adult form of the Bladder-worm is a Tape-worm (*Multiceps multiceps*, or *Tænia cænurus*) which develops only in the small intestine of the dog. It is a typical Tape-worm in every respect, consisting of a head armed with four suckers and two circles of hooklets and a large number of segments. The small head, little larger than the head of a pin, is embedded in the wall of the intestine of the dog. The segments behind the head grow larger and riper, and finally towards the end of the worm become filled with thousands of very small eggs. When this stage is reached the segment detaches itself from the tape-worm and passes to the ground with the fæces. Under suitable conditions it rots and the eggs are liberated. If the segments have dropped on to pasture land, an egg may be swallowed by a sheep, either with grass or with water. In the digestive tract of the sheep the shell of the egg is dissolved and a small larva is liberated. This is armed with six minute hooks and with these it burrows into the wall of the intestine, reaches a blood-vessel and is carried passively to the brain or spinal cord. In no other position will the larva continue to develop. Here it becomes a

thin walled cyst on which numerous tape-worm heads are found. This cyst differs from the Hydatid in that no Brood-capsules are formed. If the Bladder-worm is swallowed by a dog, the cyst wall is digested, and each head develops into an adult Tape-worm. It will be observed that each Tape-worm produces thousand of eggs, only one of which is necessary to kill a sheep. The writer has seen nearly four hundred complete worms, each two or three feet long, recovered from a single sheep-dog in Scotland. Such an animal is capable of an enormous amount of unconscious damage.

The cyst, or Cœnurus as it is called, may grow to the size of a hen's egg or even larger. It is generally found in the brain, where it is round or oval in shape. Less frequently the Bladder-worm occurs in the spinal cord, where it is elongated on account of the shape of the bony canal.

As the Cœnurus grows, it presses on the surrounding brain substance and destroys it. The skull close by becomes softened and unless the cyst is removed the sheep will die.

The symptoms of this disease are too well known to require detailed description. They generally fall into the following stages.

The first stage occurs shortly after infection. The young Bladder-worm has reached the brain in which it is moving about, seeking for a suitable place to develop. The symptoms are usually slight—a mild fever and general restlessness, but if the infection is severe (as for example, when the animal has swallowed an entire segment) the sheep may die. If the animal survives, symptoms disappear—they may never have been noticed.

The second stage occurs about six to eight months later. By now the cyst has grown considerably and the immature heads have appeared. These heads can be turned inside out so that their hooklets come into contact with the brain substance and increase the irritation caused by the pressure of the cyst. The symptons depend to some extent on the actual position of the parasite.

If the worm is on the surface of the cerebrum, the animal commonly walks in a circle towards the affected side. If it is located elsewhere, it causes other pecularities of gait, such as walking with the head held high with a "trotting" action, or head held low with a stumbling walk, and so on. The animal becomes emaciated; it is "absent-minded" and difficult to herd. Unless the sheep can get rid of the parasite it dies in about nine months after infection.

Treatment for the disease is surgical and should not be carried out in a haphazard manner. Strict asepsis is necessary, and if all due precautions are observed the animal has a fair chance of recovery. Obviously, however, the deciding factor in the course to be adopted, whether to treat the animal or whether to slaughter it before it loses condition, is an economic one depending on the value of the sheep.

Prophylaxis is more important. The Bladder-worm, if it does not reach a dog, dies. The eggs of the Tape-worm, if they do not reach a sheep, also die, so that if one prevents either of these from happening the disease can be eliminated. If all infected parts are destroyed, dogs cannot become infected; and if all dogs are kept free of Tape-worms, sheep cannot be infected. In passing it is of

interest to note that a dog will eat a Tape-worm cyst, in preference to almost any other part of the offal. The Gid parasite may occur in cattle, horses or even man, although commonest in sheep.

Sheep Measles.—The third and least important in this country of the Tape-worm diseases spread by the dog is "Measles" in sheep. This condition is caused by an entirely different parasite from those causing Measles in pork or beef. In these cases the adult worms are found only in man. In the case of the mutton form, the adult is found only in the dog and is called *Tænia ovis.* "Measles" consists of a small cyst little bigger than a pea found in the muscles of an animal. The life-history of this parasite is similar to that of the forms previously discussed, but each cyst contains a single head and is called a Cysticercus. This disease is uncommon is Scotland—the writer has only observed it once, and that in the Southern Uplands.

Symptoms are indefinite and generally confined to a slight general stiffness. In extreme cases, as for example when a sheep has swallowed an entire segment, death may result. Only sheep are infected.

A more common Cysticercus in Scotland is *Cysticercus tenuicollis*, a fairly large cyst usually found attached to the fatty tissue covering the abdominal organs. It is the larval stage of *Tænia hydatigena* (*T. marginata*), a very common Tape-worm in the dog. The cyst may be several inches in diameter, but is more usually about one inch. The Bladder-worm proper is surrounded by a protective cyst formed by the tissue, and when this is ruptured the head of the larval Tape-worm may be seen. The life history is identical with the last.

This Bladder-worm is very common, and the practice of butchers of cutting away the cyst and tossing it to a dog does much to keep up the incidence. Fortunately, however, as a rule only a few are found in a single sheep and there are no clinical symptoms. If, however, a sheep is heavily infected it may die from excessive bleeding from the liver caused by the wandering of the parasite. Pigs and cattle are also infected, but in Scotland, at least, to a lesser degree.

The last four conditions are caused by Tape-worms of the dog or his relations. *Echinococcus* is easily recognised by its small size in the fæces after administration of a vermifuge, and the animal should be destroyed in the public interest. In the case where the intermediate stage is a Cœnurus, the infection in the dog is usually a heavy one; where it is a Cysticercus it is comparatively light. In this country two other Tænias occur in the dog, which find their intermediate host in the rabbit. All five forms are so similar that the aid of the microscope is usually necessary before one can be sure of a species. Another and very common Tape-worm found in the dog is *Dipylidium caninum*, which has as its intermediate host the dog-flea or the biting-louse. It may be transmitted to man, but it is of no importance to the agriculturist. The segments voided in the dog's fæces are shaped like a cucumber seed, and can move about by themselves. The same species occurs in the cat, in which it never reaches such a large size. It is very common in Scotland, especially in town animals.

Tongue-Worm.—This parasite, in spite of its name and appearance, is not a worm, but a very degenerate relation of the ticks and mites. It is found in the nasal passages of the dog, but is uncommon in Scotland. The writer has only a single record of its occurrence in recent years. On account of its position it is frequently overlooked, in spite of its length of some three to four inches. The symptoms in the dog are ill-defined and its presence is seldom suspected. It is, however, the occasional cause of fits and attacks resembling those of Rabies, and it is probably more common than reports indicate. The eggs are passed on to the vegetation and are swallowed by some mammal—sheep and cattle are most commonly infected, but any animal, including cats, pigs and man may harbour the parasite. The eggs hatch in the stomach and the embryos encyst in many organs—liver, kidneys, lungs and so on. The larvæ develop in these cysts and then migrate through the tissues until they reach one of the body cavities. They may even perforate the intestinal wall and cause death in that way. How the larvæ reach the nasal cavity of the dog is unknown. The larval stage is easily overlooked in the carcase, but it may be a serious parasite, even causing the death of the animal.

Ticks and Ectoparasites.—The ticks in this country are not particularly serious parasites, but "Louping Ill" is probably, and "Red-water" of cattle is certainly, carried by ticks. The commonest transmitter of these diseases is *Ixodes ricinus*, a three-host tick. By this is meant a tick which leaves its host between each moult and seeks a new host immediately after casting its skin. It thus lives on three hosts before finally laying its eggs, after which it dies. The dog may and does usefully act as a host to *Ixodes* during one or more of its stages, and so tends to nullify the efforts of tick eradication and to transmit the disease to previously clean areas.

The different varieties of *Sarcoptes scabiei* are the cause of mange in the domestic mammals and man. The dog has its own particular strain, but all the varieties seem to be to a certain extent interchangeable. Sarcoptic mange in this country is found on the horse, cattle, dog and man. Abroad it is also found on sheep, goats and pigs. Psoroptic mange (Sheep Scab, etc.) is not transmitted to dogs, but they may act as mechanical carriers.

The fleas of the dog are of little interest save to himself and his master, who may be badly infested, while both species of dog-lice live on this animal only.

Ringworm and allied conditions seen on the skin on man and animals are in all cases due to Fungi and not to animal parasites at all. Several species occur in each of the domestic animals, and some at least of those in the dog may be transmitted to man and to various farm animals. How many it is not definitely known.

Conclusion.—All the above diseases are found in Scotland, and many are actively transmitted by dogs to stock. The greatest and most obvious danger is from the ownerless dog—a class of animal fortunately uncommon in this country. The authorities have the necessary power to eliminate this animal. Almost as dangerous, however, is the dog with an irresponsible or careless owner—and their number is legion. The dog which is properly trained and

disciplined, and which is kept under proper conditions of confinement, housing and feeding, is an invaluable friend and ally to the farmer. Otherwise he is at least a nuisance and often a menace to the community.

Many of the above diseases are easily eliminated or at least kept under effective control if all dogs are properly restrained, and if all infective material is destroyed. Feeding the dog on good clean food is essential, but in itself is of little value unless infective offal, Tape-worm cysts and so on, are destroyed. The dog, in spite of feeding, will, on account of his ingrained instincts as a scavenger, duly seek them out and devour them. Farm dogs especially must be periodically inspected for parasites and carefully treated. More than one course of treatment for Tape-worms is essential. In fact the medicine should be repeated at intervals until no more worms are passed. Proprietary remedies are often of doubtful value. Each type of worm requires its own special drug, and a pill which guarantees to remove all worms must be looked upon with suspicion. In the aggregate the damage done to stock must amount to millions of pounds—and it is practically all preventable.

THE following article has been contributed by Sir Jas. Wilson, K.C.S.I.:—

Farm Wages and Working Hours in Scotland in Summer 1924.

The Board of Agriculture have issued a return showing the rates of wages and allowances now received by the farm-workers in each county of Scotland according to information obtained from the local agricultural reporters. In some cases the allowances of house, oatmeal, potatoes, milk, etc. have evidently been estimated at their retail value; but, following the rule which was adopted by the Agricultural Wages Committees, I have calculated them in all cases at wholesale prices. As local prices cannot at present be ascertained, I have assumed the following rates for the whole of Scotland—house and garden, £5 per annum; oatmeal, 2s. 6d. per stone; potatoes at the time the last main crop was lifted, £3, 10s. per ton; potatoes in the drill, £5 per 1600 yards; milk, 1s. per gallon as an average for the twelve months; coal, £2 per ton; cartages, £1 per annum. I have made other slight alterations in some of the figures, based on the reports given in the newspapers regarding the results of the hiring fairs held at last Martinmas and Whitsunday, and venture to put forward the following rough estimate of the present average weekly earnings of some of the more important classes of farm-workers. It may be compared with the similar estimate of a year ago which appeared in *The Scottish Journal of Agriculture* for October 1923.

Married Ploughmen.—In the eastern part of the central industrial area, which comprises Fife, South Forfar and the Lowland part of Perthshire, the married ploughmen are generally engaged for a year from Martinmas; but in the rest of Scotland new bargains are made with them at Whitsunday, generally for a year,

except in the Lower Clyde Valley in the neighbourhood of Glasgow, where six months engagements are the rule. The result of these arrangements is at present approximately as follows:—

Average Weekly Earnings of ordinary Married Ploughmen in Summer 1924.

County.	Cash.	Allowances.	Total.
	s.	s.	s.
Wigtown	23	14	37
Kirkcudbright	34	4	38
Dumfries	34	4	38
Selkirk	33	5	38
Roxburgh	33	5	38
Berwick	35	5	40
Peebles	36	5	41
East Lothian	35	4	39
Midlothian	37	4	41
Linlithgow	38	4	42
Stirling	37	4	41
Dumbarton (Lower Clyde Valley)	38	4	42
Lanark "	38	4	42
Renfrew "	38	4	42
Ayr (North)	37	5	42
Fife (North-East)	28	11	39
Perth (Lowland)	27	11	38
Forfar (South)	28	11	39
Kincardine	27	11	38
Aberdeen	24	11	35
Banff	26	10	36
Moray	26	11	37
Nairn	23	12	35
Inverness (East)	22	12	34
Ross and Cromarty (East)	24	12	36
Sutherland (East)	18	15	33
Caithness	16	14	30
Orkney	14	10	24
Shetland	30	...	30

The arithmetical average for these 29 counties is 37s. 5d. (cash 29s. 7d., allowances 7s. 10d.), which may be compared with the corresponding average for summer 1920 of 53s. 9d. (cash 41s. 5d., allowances 12s. 4d.), and with the corresponding average for last summer of 37s. 3d. (cash 29s. 10d., allowances 7s. 5d.). It is generally reported, however, that those men who stayed on in their former employment and made their bargains with their employers at home secured better terms than were got at the hiring fairs by those men who changed their places. I would therefore estimate that for all Scotland the present average weekly earnings of married ploughmen are at least 38s., as compared with 22s. in summer 1914 and 55s. in summer 1920, and with 38s. in summer 1923—an increase of about 73 per cent., as compared with summer 1914. According to the Labour Gazette's statistics the cost of living is now (August 1924) 71 per cent. above what it was in July 1914; so that it would appear that on the whole the married ploughmen in Scotland are still in a position to maintain their

families at a standard of comfort equal to that which they had attained immediately before the war, more especially when it is remembered that many of the houses occupied by them are now worth in renting value considerably more than £5 a year, and that in this calculation the allowances have been reckoned at much lower values that the retail prices which have to be paid by other classes of workmen.

On the whole very little change has been made in the general rate of cash wages as compared with a year ago, the principal change being that in the Lothians and in the important Glasgow area, by agreement between the local branches of the Farmers' Union and the Farm Servants' Union, there was a general increase at last Whitsunday of 1s. per week. In the southern and south-eastern counties the ordinary married ploughman now receives total earnings of the value of about 38s. a week. In the Lothians the total earnings vary from 39s. in East Lothian to 42s. in Linlithgow. In the Lower Clyde Valley near Glasgow they come to about 42s. From Fife northwards as far as Kincardine along the east coast the total earnings are 38s. or 39s. Further north from Aberdeen to Ross they vary from 34s. to 37s. Further north again their value decreases to 30s. in Caithness and Shetland and to 24s. in Orkney, where there are very few married ploughmen, and where perhaps the allowances are worth more than the 10s. at which they are valued.

Single Ploughmen.—In the case of single ploughmen it is difficult to strike an average, because (1) some of them, besides their cash wage, receive board and lodging in or near the farm-house, while others live in bothies and receive allowances similar to those received by the married ploughmen, but less in quantity; and (2) the wages paid to single men vary greatly according to their varying experience and capacity. In the south-eastern counties, where the single ploughmen are generally engaged for a year from Whitsunday, get no allowances and live with their parents or relatives, the reporters give the average wages of single ploughmen as 34s. a week, ranging from 32s. in Roxburgh and Selkirk to 36s. in Midlothian and Linlithgow. In the rest of Scotland the single men generally make a new bargain every six months. In the Lower Clyde Valley and North Ayr single ploughmen are reported as getting on the average 21s. a week, besides board and lodging, which may be valued at 15s. In Perthshire, where the single men usually live in bothies, and get fire and light and allowances of oatmeal and milk, which may be valued at 8s., the cash wages average 27s. In the north-eastern counties, where the single men generally get board and lodging valued at 13s. a week, the cash wages of single ploughmen are reported as averaging a little over 22s. a week. In Sutherland and Caithness their total earnings are valued at 26s. and in Orkney at 24s. a week. Little change in the cash wages of single ploughmen seems to have taken place at the last two terms, and their total earnings now average for all Scotland about 34s. a week (cash 20s., board and lodging 14s.), compared with 38s. for the married ploughmen.

Women Workers.—In the south-eastern counties (Roxburgh, Berwick, East Lothian and Midlothian) it is common to employ

women to work in the fields, engaging them for a year from Whitsunday at a cash wage fixed at so much per week, plus a harvest fee of from £1 to £2, and sometimes a small allowance of potatoes. These additions may be reckoned as worth about 1s. per week for all the year round. In 1914 their average earnings seem to have been about 13s. a week. In summer 1920 they had risen to an average of about 30s. The cash wages now vary from 20s. to 23s. per week, and the average earnings of the women out-workers in these four counties may be estimated at present as about 23s. per week (cash 22s., allowances 1s.). In the rest of the country women working on farms on other than temporary engagements are generally employed as dairymaids or kitchenmaids, and are boarded and lodged in the farm-house. In some areas the supply of such women has been insufficient, but there was little change at last Whitsunday in the rate of wages paid them. In most areas in the centre and south of Scotland an experienced kitchenmaid is paid a cash wage of about £18 for the half-year, and experienced dairymaids in Stirling, the Lower Clyde area and Ayrshire get from £20 to £25 for the half-year. Casual women out-workers are generally paid from 3s. to 3s. 6d. a day, rising to 4s. at harvest and potato-lifting.

Working Hours on Farms.—Little or no change seems to have been made at last Whitsunday as regards working hours, which vary greatly from one county to another, and sometimes even from farm to farm. Perhaps the most definite arrangement is that come to by agreement and after arbitration last year in East Lothian. It will be found described in detail in the *Journal* for October 1923. Briefly, in addition to doing stable work on week days and Sundays, averaging about 7 hours a week, and spending on the average about 20 minutes on ordinary working days and 10 minutes on Saturday half-holidays in bringing the horses home from the field, the ploughman in East Lothian is expected to work in spring and summer for 50¾ hours a week—that is, 9 hours on 5 days and 5¾ hours on Saturdays. For 4 weeks in seed-time the working week is 54 hours—that is, 9 hours on 6 days, including Saturdays. During 6 weeks at harvest it consists of 58½ hours—that is, 9¾ hours a day for 6 days, including Saturdays. In winter the day's work depends on the length of daylight, and the working week is reduced to 41¾ hours during the last fortnight of December. The time-table allows for a half-holiday on Saturday in 42 weeks—that is, in every week except the 10 weeks of seed-time and harvest. It means an average for the year of a little less than 50½ hours per week excluding stable-work. A similar time-table has been adopted by agreement in Midlothian and Linlithgow.

In Berwick the working-day from 1st February to 15th November is 9 hours, reckoned from stable to land's end, except that 10 hours are worked during harvest; from 15th November to 1st February it is 8 hours; there is a half-holiday on Saturdays between turnip-sowing and harvest. In Roxburgh and Selkirk the working-day is 9 hours in summer, and from daylight to dusk in winter, with a half-holiday weekly in summer. In Dumfries it is 9 hours a day, and 6 to 10 days' holidays are given in the year

with full pay. In Kirkcudbright and Wigtown it is 10 hours a day in summer, and from daylight to dusk in winter, with from 6 to 12 days' holidays. In Ayr the working week is for 55 hours in summer and 50 in winter, with 8 days' holidays in the year. In Lower Lanark it is 55 hours a week, with 6 days' holidays. In part of Dumbarton it is 52½ hours a week, which allows for a short day on Saturdays. In Stirling work is done for 10 hours a day on ordinary days, but, except in seed-time and harvest, there is a half-holiday on Saturdays. In Kinross, Clackmannan and south-west Fife work is done for 9 hours a day, and 6 days' holidays are given in the year. In north-east Fife the bargain is for 9 hours on ordinary days, but 10 hours during harvest, with a half-holiday on 42 Saturdays in the year. In Perth, Forfar and Kincardine the general rule is 9 hours a day for 5 days a week, and 5 hours on Saturday, except in harvest, when, if the weather permits, work is carried on for 10 hours on 6 days a week; but on some farms the usual summer day's work lasts for 9½ hours, with 5 hours on Saturdays, except in harvest-time.

In Aberdeen and Banff the general rule is 9½ hours a day, except in harvest, when work is carried on for 10 hours, with no half-holiday on Saturdays, from 6 to 8 holidays being given in the year during slack seasons. In Moray and Nairn, 10 hours during harvest, and 9 for the rest of the year, with a half-holiday on Saturdays in slack times. In the east of Ross-shire the average working-week is 50 hours, allowing for a half-holiday on 42 Saturdays in the year and 4 full holidays. In the east of Sutherland and in Caithness the rule is a 9-hours' day in summer, with a half-holiday on Saturdays, except in harvest, when 10 hours are worked for 6 days a week. In Orkney, Shetland and the West Highlands, where work is often stopped owing to bad weather, the ploughman is expected to work on fine days in summer for 10 hours.

The general tendencies are, in the east of Scotland, towards a nine-hour day in summer and a ten-hour day in harvest, with a half-holiday on Saturdays, except in seed-time and harvest; in the west of Scotland, and especially in the West Highlands, where the weather is more uncertain, it is more usual to work longer hours in fine weather, without any regular half-holiday, a number of full holidays with pay being granted instead at slack seasons of the year. Everywhere fewer hours are worked during the short days of winter, and work in the fields is liable to be interrupted by wet weather. On the other hand, the ploughman has to spend on the average about an hour a day on stable work in addition to these working hours.

Notes from Craibstone.

Methods of Grazing.—A very important point in connection with the management of a field of pasture is the method of stocking practised. Some farmers believe that stock do better if they are moved frequently from field to field than they do when confined to the same field during the whole of the season. In order to gain information on this point, an experiment was carried

out at Craibstone for three seasons. A field of 15 acres was divided into three plots of 5 acres each. Seven head of cattle were put on one plot and kept there during the whole of the season. Fourteen head of cattle, on the other hand, were put on plots 1 and 2, being kept on one or other of these plots until it was considered that it was eaten sufficiently bare, when they were moved to the neighbouring plot. As the summary given below shows, the cattle which were confined to the one plot during the whole of the season did best. This is contrary to what is generally expected. It would seem, however, that the failure of the other system was due to the fact that the large number of cattle confined to a comparatively small area ate the pasture down so bare that it did not readily recover, and this was particularly noticeable during the drier part of the season.

SUMMARY FOR 3 YEARS.

Plots 1 *and* 2.

	Average number of Cattle.	Live weight increase per acre.			Average increase.
		Cwts.	Qrs.	Lbs.	Lbs
1919 . . .	14	1	3	26	159
1920 . . .	11	2	1	11	240
1921 . . .	14	2	1	19	199
		6	3	0	598
	Plot 3.				
1919 . . .	7	2	1	1	180
1920 . . .	5·5	2	2	14	268
1921 . . .	7	2	3	17	233
		7	3	4	681

Although, therefore, one is not perhaps entitled to draw the conclusion from this trial that cattle should not be moved occasionally to fresh pastures, it would seem clear that there is a disadvantage in too close grazing, and, therefore, where a comparatively large head of cattle is kept relative to the area, they should be moved very frequently so that the new grass may be eaten uniformly but not too bare.

As a corroboration of these results from grazing, the same effect was found by mowing part of a field very frequently during the season and comparing this with the amount of forage got by mowing a similar area only two or three times. In the experiment referred to, two plots of equal area in a field were selected; one plot was mowed six times during the season and the other plot mowed twice. In the latter case, the grasses had reached almost maximum growth before being cut, and it was very noticeable that in this case the grasses recovered much more readily than on the other plot, where mowing had taken place more frequently.

Autumn Sown Mashlum.—Throughout the North of Scotland the majority of farmers usually sow out a matter of 2 to 3 acres

of mashlum for late summer or early autumn feeding. This mashlum is almost invariably sown in the springtime. It is only under very favourable weather conditions that the crop is ready for feeding much before the end of August. As, however, there is very often a demand for some green material in the spring and early summer, it was thought that this might well be supplied with mashlum sown in the autumn, and with a view to finding how far mashlum could be successfully sown at this time, and what particular mixture of seeds would be most suitable, an experiment has been carried out at Craibstone during the past two seasons. The mixtures consisted of a cereal—wheat, rye, oats or barley—along with vetches, beans and peas. It has been found that, of the cereals, rye and wheat are much superior to barley or oats. Oats have always turned out to be an almost complete failure, and barley, although it makes considerably better growth, is found to go into ear very readily, and in this condition is not very palatable to stock. Rye comes much earlier in spring than wheat, and is, therefore, the most suitable cereal for mashlum required early in the season. Rye, under favourable conditions, should give a good cut in the month of May. The only disadvantage, however, with the rye is that at this season the vetches have not made much headway, and, therefore, when cut very early, the crop consists almost entirely of rye. Wheat is considerably later than the rye, but by the month of June a good cut should be got from the wheat mixture, and it will contain relatively more of the vetches and beans than the rye mixture. The rye, too, like the barley, very readily gets into ear, whereas the wheat remains green and succulent for a much longer period. In both seasons the peas were a complete failure.

The conclusions drawn from these limited trials are—that for very early cutting, a mixture which might be tried would consist of 1½ cwt. rye, ¾ cwt. vetches, and 1 cwt. beans; for later cutting, 1½ cwt. of wheat should replace the rye.

It is, of course, essential that the crop should be got in comparatively early. In the case of the trials referred to, the seeds were sown about the third week of September. A slight dressing of artificial manures was also applied with a view to getting the plants well established before winter set in. It was at first intended that the crop should be dressed with sulphate of ammonia in the springtime, but in both seasons the crop was looking so well that it was considered unnecessary to do so. The average yield from the two mixtures referred to above was about 14 to 16 tons per acre.

The above notes have reference to mashlum that is to be cut and fed green. If the material is to be made into silage it would be advisable to use both rye and wheat in the mixture, because in silage, although the rye is into ear, it will still be readily taken by stock; another advantage is that it stands longer and tends to keep the vetches up.

Formalism in the Breeding of Live Stock.

THE following extracts are taken from an article by Mr. C. Wriedt, Norway, in Vol. II., No. 2, of the *Review of the Science and Practice of Agriculture*, published by the International Institute of Agriculture :—

The characters to be aimed at in breeding have for the most part been settled by experts at fairs or shows, but frequently competition has played a decisive part in directly encouraging breeding for certain economic qualities. There is no doubt that the rivalry between breeders of butchers' beasts has greatly contributed to the development of the present type of cattle in England.

Further, competition has been the cause of fixing a certain coat-colour or the position of the horns as characteristic of a particular breed. This desire for uniformity has had the unfortunate result that domestic animals which do not conform to the standard, especially as regards coat-colour, are often slaughtered, although not all the individuals were destined for breeding purposes.

In the case of horses, however, all the foals are kept, and therefore the tendency to uniformity is not so marked as in other live-stock, except in certain instances where matched animals are required, which justifies severe measures being adopted to insure uniformity

In sheep-breeding, rigorous selection is practised with the object of obtaining a white fleece, which is of real economic importance, since white wool dyes more easily than coloured wool.

The sheep-breeding industry has, however, suffered from formalism, to which must be attributed the demand for a black muzzle in white Cheviots, and although, in spite of selection for many years, lambs with white muzzles frequently appear, this deviation from the accepted standard is considered of such importance than when a white-muzzled lamb is dropped by a Cheviot ewe, the fact is duly registered in the Flock-book. Indeed I have seen flock-books in which the colour of the lamb's face was the only character entered. Black patches on the ears and legs in the Cheviot breed are looked upon with disfavour.

The thick covering of wool which is *de rigueur* on the head of Shropshires and many Merinoes often interferes with the sight of the animals as the wool comes over their eyes.

In our country there is some reason in requiring that pigs should have a white coat, for the consumers often object to a dark skin, but in southern lands, pigmented swine are superior to others because they resist the sun better. Pure formalism as regards colour has, however, prevailed in some cases, since only the standard coat-colour is admissible in Berkshires, Poland-Chinas, etc.

The long, pendant ears of many of our native breeds of pigs are another instance of the tendency to formalism.

The Large Yorkshire should have a long, slightly turned-up snout, and long erect ears. These characters appear to be a heterozygous combination, for among the pigs of this breed there occur very frequently types with either the short snout of the Middle Yorkshire, or the long snout and pendant ears characteristic of the native swine.

This strict adherence to various standard points may have

great disadvantages in the breeding of sheep and pigs and may exclude the use of breeding animals possessing the most important economic characters, although since these animals grow very rapidly, and the number of individuals from which to select is large, formalism does not exert such a deleterious influence from the economic standpoint as in the case of other live stock that develop more slowly and whose sexual maturity is consequently later.

The Hereford is a breed in which coat-markings are regarded as of great importance. These cattle should have a white head, chest and belly, white legs and tip to tail, while a white line runs along the back of the neck. For at least 70 years this breed has been selected in order to fix these particular coat-markings, but in spite of Pitt's researches, homozygous markings have not been obtained even in the best lines, and calves are regularly born with too much white about them.

The colour of the muzzle is also a very important breed character. Shorthorn cows must never have a slate-coloured muzzle; this character excludes the animals from the Herdbook in Germany, while their registration in Denmark is a matter of considerable discussion.

Formalism has not only greatly extended its influence in determining coat-colour, for we find that practical authorities on cattle breeding have also turned their attention to the horns and their position. In Germany appliances for giving horns the required shape have been advertised. The bony excrescences occurring in hornless breeds are not appreciated, and in Norway cows with these rudiments sell for lower prices than others.

As regards the external conformation of cattle, many points are required in show animals, but the balance is kept between the purely formalist and the wholely utilitarian standpoints. A well-formed udder is of practical importance; but it would not be justifiable to lay too much stress upon this character. Many of the external characters required in show animals are of no practical importance, and the disfavour with which a sloping croup in cattle is regarded appears unreasonable.

As regards milking characters, the question appears to be settled to a certain extent since Gowen's researches, for cows are regarded solely from the dairy point of view.

It can well be understood that before the laws of heredity were known, much economic importance was attributed to the external characters of domestic animals. Now, however, on the contrary there is no reason to preserve the formal characters of the breed, because we know that the chromosomes are the bearers of heredity in the case of all living organisms, and that this heredity in any given species is more complicated in proportion as the number of chromosomes increases.

The number of pairs of chromosomes present in the following domestic animals is: pigs 20; large cattle 16-17; horse 19, but these figures are increased by the possible combinations, which, in the case of swine, are most numerous and varied.

In our domestic animals there are so many important economic characters to be discovered by selection, and these characters

depend upon such a large number of hereditary factors, that it is impossible for the breeder to pay attention to any qualities not having great practical importance. The only reason justifying selection directed to obtaining a character of no economic value would be the hope of discovering a combination of hereditary factors that would in its turn give rise to an important economic quality. On account of the large number of chromosomes possessed by our largest domestic animals, it is very unlikely that sufficiently powerful combinations will be found to be of any practical utility.

The modern doctrine of heredity shows clearly that the method adopted for the elimination of recessive, atypic breed characters is quite useless. Refuge has been taken in killing, or excluding from breeding, all animals that do not reach the required standard.

In most of these instances of formalist selection, the difference between the typical and the atypical individual depends upon a single hereditary factor, so that it is possible to calculate how quickly the number of recessives can be reduced as soon as these are excluded.

Colour transmission in the Aberdeen-Angus breed may be cited as an instance where the troublesome recessive factors have not been got rid of, even by the elimination of the recessive individuals. For at least 50 years a selection of entirely black individuals was carried out within this breed, but according to Watson, red calves, or calves with the objectionable white spots on their legs, were of frequent occurrence.

Naturally, it is possible to obtain a breed homozygous as regards the dominant hereditary factor required, provided all individuals that are heterozygous for the recessive hereditary factor are eliminated, but no one would like to take upon himself the responsibility of rejecting a breeding animal with a good hereditary record of important economic qualities, even if it were heterozygous for an hereditary factor of no practical value.

It is quite certain that if the breeding authorities were, for instance, to exclude from the Herdbook and refuse prizes to all cattle producing a red calf, such calves would very rarely make their appearance in that breed. The struggle against characters depending upon hereditary recessive factors is, and will remain, fruitless; therefore there is no reason in burdening the practical breeder with the expense entailed.

It is different where we have to do with characters depending on hereditary factors that have proved to be more, or less, completely dominant. In this case it is possible to eliminate entirely all undesirable characters, although great injury may be caused if this elimination is pushed to undue lengths. We are well aware from the study of the origin of the various breeds that the individuals forming the original stock and maintaining the breeds were few in number, and that some of them may have been the offspring of animals possessing an undesirable hereditary dominant factor.

As regards the characters dependent on hereditary factors that are more or less dominant, and have no direct economic importance, they should perhaps be carefully eliminated.

The Second World's Poultry Congress.

AT the invitation of the Spanish Government, the Second World's Poultry Congress was held at Barcelona in May 1924 under the Honorary Presidency of His Majesty King Alfonso and His Royal Highness the Prince of the Asturias. Twenty-five countries were represented by some 160 delegates, including several eminent research workers in the poultry world, and by a number of poultry breeders, administrative officials and others. Seven of the visitors, including two College poultry instructresses, were from Scotland.

The members were received with official honours and treated with generous hospitality. The Congress was ceremoniously opened and closed in the Grand Hall of the University of Barcelona, and the paper reading sections met within the Exhibition Buildings. The sections numbered four and were devoted to:—

Section I.—Research and Investigational Work.

Section II.—State-aided and Voluntary Efforts to Develop the Poultry Industry (inclusive of Educational Work).

Section III.—Hygiene and Disease.

Section IV.—National and International Trade in Eggs and Poultry.

Papers were contributed from Scotland on "Sex-Reversal in the Domestic Fowl," by Dr. F. A. E. Crew, and "The Influence of Cod Liver Oil on Growth and Egg-production in Poultry," by Dr. J. B. Orr.

The chief impressions gained from the papers read are that (1) transport difficulties in regard to the marketing of poultry and eggs are common to most countries; (2) diseases of poultry are on the increase and are viewed with alarm, and preventive and remedial measures in regard to diseased birds are largely used in the United States of America and Continental Countries, where disease restrictions are enforced; (3) in all countries which were represented there is a general improvement in the class of poultry kept, and the industry is considered of increasing value to the welfare of these countries; (4) schemes for the certifying of breeders' farms, birds, hatcheries and methods of management are being adopted by the Canadian, American, New Zealand and other Governments, many of which have elaborate methods of inspection and registration; (5) Holland, Denmark and Czecho-Slovakia are giving very special attention to poultry-production and co-operative marketing.

At the closing session of the Congress the following resolutions were considered:—

(*a*) That it is desirable that aviculture research institutes, similar to that described in the report of Mr. H. E. Dale of London, should be established in all countries. (Adopted.)

(*b*) While addressing its congratulations to the Italian Government, resolves that it is desirable that the measures adopted by the Italian Government should be initiated everywhere where the need is felt, particu-

larly by means of the creation of aviculture research sections in existing agricultural institutes. (Adopted.)

(*c*) That it is desirable that uniform examination rules should be fixed by International Convention for the International and National Egg Trade. (Adopted.)

(*d*) (1) That it is desirable that the standards of the countries of origin should be communicated to the respective Federations and Associations of all countries. (Adopted.)

(2) That it is desirable that the various breeds to be judged at exhibitions should be defined with greater precision by measurement of different parts of the body and by a statement of size and weight, and to establish a Committee. (Rejected.)

(*e*) That it is desirable that an International Federation of Aviculture should be constituted. (Left to Societies.)

(*f*) That it is desirable that the Ministers of Agriculture, Railways and Customs of the different countries should get into touch for the purpose of arranging:—

(1) That a uniform tariff should be fixed for the delivery and return of consignments intended for aviculture at exhibitions.

(2) That the documents to accompany consignments should be simplified and standarised.

(3) That the Customs formalities should be simplified.

(4) That the formalities of Customs should also be carried out on exhibition premises.

(5) That the certificate issued by the Committee and the Veterinary officer should be accepted in return for passing the frontier. (Adopted.)

On the marking of imported eggs, practically the same resolution as was passed unanimously at The Hague was put to the meeting and carried; but in view of a protest from the French and Italian delegates that the proposition had not been understood by them, the discussion was re-opened, and it was ultimately decided that the vote should be by countries.

It was unanimously agreed that the Exhibition, which was held in the buildings already completed for the Universal Exhibition to be held at Barcelona next year, was the finest that has yet been seen in the poultry world.

The Spanish exhibits occupied the Palace of Modern Art, and in the Grand Hall to which it forms an Annexe the foreign exhibits were housed,—birds occupying the centre, while the side bays were given over to educational displays. In the Spanish Section the exhibits were magnificently staged amid "scenery," palms and flowers, with beautiful artificial lighting effects.

The foreign birds looked remarkably well notwithstanding their long journeys, and were shown to advantage as regards lighting and spacing, but the pens were too small for the majority of our British breeds. Scotland was represented by three pens of ducks and a pen of Barred Rocks, which were favourably compared with the Canadian Barred Rocks.

The British poultry distinctly excelled that of other countries, but not to such a great extent as was noticeable at The Hague. Italy showed a very fine selection of guinea fowls and France and Belgium showed a large number of rabbits for meat and fur. There were also exhibits of bantams, turkeys, geese, pigeons and coloured birds of many varieties from several countries.

The educational exhibits were most interesting and instructive and many of the countries had taken in Trade exhibits. The State which created most interest was Czecho-Slovakia, ably represented by Dr. Maria Kuklova—the only woman speaker at the opening of the Congress. In this young State the poultry industry is strongly supported financially by the Government, and its educational exhibit showed what complete research sections have been set up to aid the industry. Good exhibits were also made by Italy, France, Holland, Denmark, Canada and the United States. The British educational display was commended by the foreign delegates, but was criticised by British visitors, who realised how far it fell short of what we have to show. Dr. Crew's exhibits showing sex reversion, Dr. Orr's charts on nutrition experiments, and those of Professor Punnet and Colonel Mackworth showing sex-linked inheritance created much interest.

Chemistry and the State.

THE presidential address delivered by Sir Robert Robertson, K.B.E., F.R.S., to the Chemistry Section of the British Association at Toronto on August 7th forms the subject of an article in *Nature*, No. 2863, Vol. 114. It contains a summary of the State's chemical activities before, during and after the war, and the following extracts deal with chemistry in its relation to agriculture during these periods.

Before the War.—Science was being applied to agriculture about the end of the eighteenth century, and at the beginning of the next Davy did pioneering chemical work for the Board of Agriculture. Private endeavour is responsible for the next development, State action being limited to the prevention of fraud in the sale of fertilisers and feeding-stuffs. In 1909, however, the annual allocation of a sum of money to the Development Commission for the advancement of agriculture stimulated research in a large number of institutions engaged in the scientific study of problems in which chemistry plays an important part.

During the War.—Effects on agriculture during the war were shortage of the usual feeding-stuffs for cattle and of fertilisers. The chemists stationed at Rothamsted gave special attention to the shortage of manures and prepared instructions for the guidance of farmers; and several sources of supply of potash were exploited, including kelp, felspar and the flue-dust of furnaces. As sulphuric acid was required for explosive work, fine grinding of phosphates and basic slag was adopted and found to be more efficient than was expected. Shortage also directed the attention of chemists to the use of little known food-stuffs, especially for cattle, and the information gained as to their feeding value was important.

After the War.—So far as fertilisers are concerned, the lack of a supply of fixed nitrogen from the air which obtained throughout the war has now been rectified, and Great Britain for the first time is no longer exceptional among the nations by neglecting to provide itself with synthetic ammonia for agriculture and for munitions. Such war-time expedients as the use of nitre-cake instead of sulphuric acid for making ammonium sulphate and superphosphate, and the recovery of potash from flue-dust, have not survived, but there has been a gain in the further development of "synthetic farmyard manure" and the increased use of basic slag. The present activity in research in agricultural chemistry of a fundamental character is leading to a better understanding of problems of the soil and of plant and animal nutrition, and cannot fail to be of ultimate benefit to farming.

Scottish Women's Rural Institutes.

THE Scottish Women's Rural Institutes have now nearly completed two years of self-government. In accordance with a decision arrived at in conjunction with the Treasury, the provision previously made on the Board's Vote for the central administration of the Institutes ceased at 31st October 1922, and the measure of control exercised by the Board over the general policy of the Institute movement was removed, except with reference to the grant of public money mentioned below.

The constitution of the Institutes provides for County Federation Committees, five Area Committees, and a Central Committee, the last comprising two members elected by each Area Committee. It also provides that Area Conferences shall be held biennially. The Committee for each area is responsible for the organisation of Institute work therein and for the administration of the funds available. The Area Committees are, however, recommended to discharge their duties as much as possible through the county federations, which with the rapid growth in the numbers of Institutes have now become a necessary part of the organisation.

The joint office of the Central Council, the Central Area and the North-Western Area is at 8 Kinnoull Street, Perth; the office of the North-Eastern Area at Prudential Chambers, Crown Street, Aberdeen; and the joint office of the South-Eastern and South-Western Areas at 74 Great King Street, Edinburgh.

The Institutes are to receive from the Board of Agriculture for Scotland a grant of £15,000, payment of which is spread over five years as from 1st November 1922, out of the £150,000 provided by the Corn Production Acts (Repeal) Act for promoting agricultural development. Out of this sum, £400 is allotted to each Area Committee and £1000 to the Central Committee for its general purposes and for certain special purposes.

The Hand-Book, issued in two parts (price *6d.* and *3d.* respectively) in June of this year, shows the remarkable progress that the movement has recently made. The number of Institutes in Scotland, which was 69 in November 1919 and 179 in November

1921, was last May 359, and has now risen to 367. The movement is thus within measurable reach of having an Institute in every second rural parish in Scotland. The great county of Aberdeen has reached this point, with 41 Institutes. Other notable counties are Fife with 32, Forfar with 26, Ayr with 24, Kirkcudbright with 22, Lanark with 21 and East Lothian with 16. Wigtown has actually 20 Institutes for 17 parishes. Perth has 28, but its parishes number 71. In the thinly populated north-western area Inverness has 16 for 32 parishes and Caithness 9 for 10 parishes.

The Area Conferences were held in May and June at Aberdeen, Perth, Edinburgh, Dumfries, Dingwall and Fort William, two Conferences being held in the north-western area. A full account of the proceedings is given in the August number of *Scottish Home and Country*, the quarterly magazine of the movement. The reports presented at the various Conferences show the wide variety of the social, educational and recreational activities that are carried on by the Institutes. A special feature is the encouragement of lace-making, leather work and rug-making, whether for sale or for members' personal use.

New possibilities are constantly opening out before the Institutes, and the organisation is on sound lines. Consideration is already being given to the situation that will arise in 1927, when the Government grant will cease. It is increasingly obvious that the Institutes have become a permanent feature of Scottish rural life, and Scottish women may well be proud of the progress that the movement has made since it began seven years ago.

The Correlation of Meteorological and Crop Data.

WITH reference to the article on this subject which appeared in the July number of the *Journal* (p. 329), it is interesting to note that the question is also attracting considerable attention in other countries. As the result of resolutions passed by the Institute of Agriculture at Rome, a Sub-Committee has been appointed by the Ministry of Agriculture in Germany for the purpose of carrying out investigations in Agricultural Meteorology. This Committee consists of representatives not merely of meteorology, but of the Biological Institute for Agriculture and Forestry and of the Institutes of Hydraulics and Agricultural Science. The Biological Institute for Agriculture and Forestry has undertaken to collect and work up data with regard to the dates of sowing or planting, flowering, cutting or lifting, etc. (phenological data) with the object of rendering statistics more useful and reliable for use in foretelling the crop yields. The Institute of Hydraulics will investigate the question of evaporation of moisture from the soil, which is a subject on which much additional information is required. The connection between the weather and the incidence of disease is also emphasised as being of extreme importance.

International Year-Book of Agricultural Legislation.

THERE has recently been issued by the International Institute of Agriculture the *International Year-Book of Agricultural Legislation* for 1923, containing for all the countries in the world the texts of laws, decrees and regulations relating to agriculture, special attention being paid to agricultural trade, taxes upon agriculture, crop production, stock-raising, the diseases of animals and plants, agricultural insurance and credits, landed property and agricultural contracts. There are two indexes, a chronological index by countries and an alphabetical subject index.

Never before has there been so much legislation regarding agriculture all over the world as in the post-war years, and the compilation of this annual volume is one of the many services that the Institute renders to agriculturists who are interested in the wider aspects of their calling. This is the first occasion on which an English edition has been published, and it is hoped that the enterprise of the Institute will meet with an adequate response in English-speaking countries.

The volume extends to over 1000 pages and may be obtained at the price of 12s. 6d. from the International Institute of Agriculture, Publications Department, Villa Umberto I., Rome (10), Italy.

Exhibition of Labour-Saving Devices.

THE Board of Agriculture for Scotland have received a preliminary announcement and provisional programme of an International Exhibition of the latest Equipment and Labour-saving Devices for use in the home and on the farm, which is to be held at Heysel, Laeken, Belgium, from 15th July to 15th August 1925.

Exhibits are invited from all manufacturers of mechanical devices and processes which are intended to lessen hand labour in the home or on the farm, and intending exhibitors are required to notify their entries before 1st April 1925. Articles require to undergo a preliminary test before a "jury of admission" before 1st May 1925.

Diplomas and medals will be awarded to outstanding exhibits.

All communications should be addressed to the General Secretary, Rue des Joyeuses Entrées, 40, Louvain.

Agricultural Conditions.

THE weather during June, although rather unsettled, was on the whole favourable for growth, and speaking generally all crops made good progress. The months of July and August were, however, less satisfactory. During this period rain was frequent and sometimes heavy, while the amount of sunshine was almost everywhere below the normal. The long spell of broken weather affected the cereals, particularly barley and oats, more or less

seriously, many of the heavier crops being badly lodged, while owing to the lack of sunshine the grain was slow in ripening and harvest promised to be later than usual in most districts. The unsettled weather also delayed the finish of the hay harvest and large quantities were still unsecured at the end of August. The rains proved advantageous to potatoes and turnips up to a point, but towards the end of August there was marked evidence of potato blight and "finger-and-toe," as a consequence of too much moisture.

Wheat promised to be the best of the cereal crops, but as already stated the grain was slow in maturing. At the end of August the crop was almost ready for harvesting in some parts of South-West Perth and South Ayr, but cutting was not general until the second or third week of September. In most of the districts in which the crop is principally grown an average yield or over was anticipated; in South-East Perth, Dumbarton and South Ayr, however, the probable yield was estimated at 5 per cent. below the normal, while in South-West Forfar the deficiency was put at 10 per cent.

The barley crop was generally healthy and vigorous, but as in the case of wheat, ripening was unusually backward, while the heavier crops were badly laid and twisted by rainstorms. Harvest had begun in Moray and Banff and the earlier districts of the Lothians at the end of August, while in several districts a start was made during the first week of September. Yields of from 5 to 10 per cent. below the normal were estimated in South-West Forfar, South West and South-East Perth, South Ayr and Dumfries, while in Berwick the estimated deficiency varied from 5 to 25 per cent.; elsewhere it was anticipated that the yield per acre would be fully up to the average. Bere was stated to be looking well, and average yields or over were looked for in most of the districts in which the crop is principally grown.

The reports on oats were varied, and were on the whole much less favourable than in the case of wheat and barley. Generally speaking the heads were fairly well filled, but considerable portions of the best crops were so badly flattened that there was little likelihood of the grain maturing. At the end of August cutting was in progress in North-East Forfar, Dumfries and some parts of the Lothians, but in most districts harvesting was not general until the second or third week of September. Yields more or less above the average were anticipated in Moray, Banff, South-West Aberdeen, Kincardine, Fife, the Lothians, Roxburgh, Sutherland, Inverness, Nairn, and Stirling, but in South-West Forfar, Berwick, Ross, Dumbarton, Ayr, and the south-western counties the ultimate yield was expected to be below the normal.

Beans promised to be a satisfactory crop in most districts in which they are grown to any extent, and it is believed that the total yield will be above the average.

Potatoes made good progress in most cases. On wet soils, however, the tubers have developed rather slowly, while in several of the more important potato-growing districts there were marked signs of blight during the latter part of August, owing to the excessively wet weather. Yields varying from average to good,

are expected in the majority of cases, and consequently the produce of the crop as a whole is likely to be above the normal.

Turnips and swedes were generally reported to be looking well. Growth was vigorous on light soils, but on heavy land the roots are rather small as a result of the wet weather and lack of sunshine. Complaints of "finger-and-toe" were received from many districts, while canker was prevalent to some extent in Central Perth and club root in Berwick. Weeds were stated to be more abundant than usual owing to the difficulty in cleaning the ground. Estimates of the probable yield varied considerably in different districts. Average yields or over were expected in Moray, Banff, most districts of Aberdeen, South-East Perth, North-East Fife, the Lothians, Berwick, Roxburgh, Caithness, Inverness, Nairn, North Argyll, Lanark, North Ayr, Dumfries, Wigtown, Orkney and Shetland; in most of the remaining districts it was anticipated that the produce of the crop would be from 5 to 10 per cent. below the normal. Mangolds were stated to be healthy and promised to be a fair crop in most cases.

The condition of small fruit was affected to a greater or less extent by the prevailing wet weather. Raspberries proved a satisfactory yield in most districts, while strawberries were a full crop in Central Aberdeen, Dumfries and Central Perth; in Banff and Lanark, however, the results were rather indifferent. Gooseberries were fairly plentiful in Lanark and Dumfries, but in Central Perth the crop did not develop satisfactorily. Currants proved an average yield in South-East Lanark, but elsewhere the yield varied from fair to indifferent. Apples were a fair crop in South-East Lanark, but in South-East Perth, North-West Lanark and Dumfries the yield will be considerably below the normal. Plums were a disappointing crop, and in several districts are described as a failure.

The rainfall during July and August benefited pasture, which in most cases was then plentiful; the grass, however, was soft, and deficient in feeding value. Grazing cattle did fairly well, but their progress was more or less affected by the wet weather in August and the inferior quality of the pasture. Dairy cows were reported to be in moderately good condition. The milk yield, however, had fallen off to some extent, particularly in the south-western counties, and extra feeding was being given as early as the end of August. Sheep on arable farms have, on the whole, done well; in several districts, however, the lambs are stated to be somewhat lacking in condition. The reports on hill sheep are also fairly encouraging.

Bees are reported to be in good condition in most districts. The prolonged spell of wet weather and the unusual absence of sunshine, however, have adversely affected the production of honey, and the yield will be light.

The supply of regular workers is generally adequate for requirements, but casual labour for harvest work is scarce in several districts.

Agricultural Returns, 1924.

THE Preliminary Statement of the Agricultural Returns taken in Scotland on 4th June, 1924 shows that the total area under crops and grass amounts to 4,715,300 acres, comprising 3,270,500 acres of arable land and 1,444,800 acres under permanent grass. The total area is the smallest recorded since 1879, and the area of arable land is the smallest since the Returns were first collected in 1866, being 19,400 acres less than that of 1915. As compared with 1923, arable land shows a decrease of 27,600 acres and permanent grass an increase of 18,500 acres, the diminution in the total area being 9100 acres.

The area under rotation grasses and clover, 1,509,400 acres, shows an increase of 3800 acres. The diminution in the area under other crops is thus 31,400 acres. This is mainly accounted for by wheat, barley, oats, turnips and swedes and rape, with a combined loss of 33,500 acres. Some other crops show increases, none of which is as great as 1000 acres.

The area under wheat is 50,100 acres, the smallest recorded since 1909, and less by 8700 acres than that of 1923; that under barley, 151,700 acres, is the smallest since 1915, and is 7000 acres less than last year; that under oats, 956,600 acres, is the smallest since 1914, and is 11,600 acres less than last year. Mixed grain and rye show increases of 700 and 300 acres respectively, while the acreage of beans is unchanged.

Potatoes, with an area of 137,800 acres, show an increase of 800 acres over 1923, but are under the average of the ten years 1914 to 1923 by about 13,000 acres. Turnips and swedes, with 405,800 acres, are 3800 acres less than last year. Rape has decreased by 2400 acres, reverting nearly to its position in 1922, while mangolds show a further diminution of 200 acres. Cabbage shows a small decrease and vetches, tares, etc., and small fruit slight increases. Of the crops not separately shown in the accompanying table, the most notable are sugar beet, which has increased from 4 to 187 acres, and flax, which from 607 acres last year has fallen to 325, about equal to its acreage in 1922.

Of the whole area under permanent grass, 162,200 acres were cut for hay and 1,282,600 acres were grazed, while of the area under rotation grasses and clover 413,900 acres were cut for hay and 1,095,500 acres were grazed. The whole area cut for hay is greater than it was last year by 8700 acres.

The live stock returns show that horses and cattle have diminished in number, while sheep and pigs have increased.

Horses used for agricultural purposes, numbering 136,800, are fewer by 2000, the number being the smallest since 1917. Unbroken horses of one year and above are fewer by 6600 or 19·2 per cent., and foals by 1800 or 21·7 per cent. The number of foals, 6500, is less than half of what it was in 1920 and earlier years. The total decrease in horses is 10,400 or 5·1 per cent.

The total number of cattle, 1,163,100, shows a decrease of 30,500 or 2·6 per cent. Cows in milk, feeding cattle over 2 years and calves share the decrease about equally, while cows in calf are more numerous by 4100, bulls are unchanged in number, and heifers in calf and yearling feeding cattle show slight decreases.

Ewes have increased by 68,600, now numbering 2,971,900, but the number of lambs is almost unchanged at 2,802,300; rams have increased by 5100, but other sheep one year and above are fewer by 21,300. Sheep of all classes number 6,840,200 or 54,500 more than last year. The increase in the last four years amounts to about 480,000.

While sows show a small decrease, and boars a small increase, others pigs have increased by 11,900, and the total number of pigs returned is 197,500, which exceeds last year's total by 11,500 and is the largest ever recorded.

The Returns also include, as usual, statistics of the acreage of crops and grass owned by occupiers of holdings, and particulars relating to labour. These figures are not included in the tables.

The total area of crops and grass returned as owned by occupiers of holdings this year amounts to 887,000 acres, showing an increase of 3500 acres as compared with last year. The rapid increase that took place between 1920 and 1923 appears now to have come to an end.

Labour employed on holdings (excluding the occupiers, their wives and domestic servants) totalled 116,100, as compared with 120,000 last year, a decrease of 3900 or 3·3 per cent. Of these, 98,900 were regular workers, comprising 78,900 males and 20,000 females, and 17,200 were casual, these being as usual about equally divided. The former are fewer by 1800 and the latter by 2100. Regular workers have since 1921 diminished in number by 5000 or 4·8 per cent., male workers being fewer by 3200 and female by 1800. Casual workers show a much larger proportional diminution, amounting to 5800 or 25 per cent. The changes in the numbers of casual workers employed on a given date are however due to some extent to seasonal differences.

It should be noted that the figures given above and in the following tables are subject to revision.

CROPS.

Distribution.	1924.	1923.	Increase.		Decrease.	
	Acres	Acres.	Acres.	Per cent.	Acres.	Per cent.
Total Area (excluding Water),	19,069,683	19,069,683		...	..	...
Total Acreage under all Crops and Grass (a),	4,715,300	4,724,400	...	..	9,100	0·2
Arable Land,	3,270,500	3,298,100	...	...	27,600	0·8
Permanent Grass (a), For Hay,	162,200	152,900	9,300	6·1	.	...
Permanent Grass (a), Not for Hay,	1,282,600	1,273,400	9,200	0·7	...	...
Permanent Grass (a), Total,	1,444,800	1,426,300	18,500	1·3	...	...
Wheat,	50,100	58,800	...	...	8,700	14·8
Barley (including Bere),	151,700	158,700	..	...	7,000	4·4
Oats,	956,600	968,200	.	...	11,600	1·2
Mixed Grain,	1,900	1,200	700	58·3	...	...
Rye,	6,700	6,400	300	4·7	..	...
Beans (to be harvested as Corn),	3,800	3,800		.	...	..
Peas	600	500	100	20·0	.	..
Potatoes,	137,800	137,000	800	0·6		...
Turnips and Swedes,	405,800	409,600	.	...	3,800	0·9
Mangolds,	1,400	1,600	..	...	200	12·5
Cabbage,	4,100	4,300	..	...	200	4·7
Rape,	11,900	14,300	..	..	2,400	16·8
Vetches, Tares, Beans, Peas, Mashlum, etc., for Fodder,	10,600	10,200	400	3·9	...	...
Small Fruit,	7,000	6,900	100	1·4	...	...
Rye-Grass and other Rotation Grasses and Clover, For Hay,	413,900	414,500	.		600	0·1
Rye-Grass and other Rotation Grasses and Clover, Not for Hay,	1,095,500	1,091,100	4,400	0·4	...	...
Rye-Grass and other Rotation Grasses and Clover, Total,	1,509,400	1,505,600	3,800	0·3	.	..
Other Crops,	3,700	3,600	100	2·8	...	...
Bare Fallow,	7,400	7,400	...	...	...	...

(a) Excluding Mountain and Heath Land used for grazing (9,293,500 acres in 1924, as compared with 9,678,200 acres in 1923).

LIVE STOCK.

Class.	1924.	1923.	Increase.		Decrease.	
	No	No	No.	Per cent.	No	Per cent.
Horses used for Agricultural purposes (including Mares for Breeding),	136.800	138.800	.	...	2,000	1·4
Unbroken Horses (including Stallions) :—						
One year and above,	27,700	34,300	..	.	6,600	19·2
Under one year,	6.500	8.300		..	1,800	21·7
Total,	171,000	181,400	...	..	10,400	5·7
Other Horses,	22.400	22,400	.	.	...	..
Total of Horses,	193.400	203,800		...	10,400	5·1
Cows in Milk,	351,300	361,700	..	.	10,400	2 9
Cows in Calf, but not in Milk,	46,200	42,100	4,100	9·7	..	..
Heifers in Calf,	49.700	51,500			1,800	3·5
Bulls being used for Service,	17.500	17,500	.	..	..	.
Other Cattle :—						
Two years and above,	215.000	225,500		.	10,500	4·7
One year and under two,	263.100	265.400		.	2,300	0·9
Under one year,	220.300	229.900	.	...	9,600	4 2
Total of Cattle,	1.163.100	1.1[illegible],600	.	.	30,500	2·6
Ewes kept for Breeding,	2,971.900	2,903.300	68.600	2·4	..	...
Rams to be used for Service in 1924,	84.000	79.800	5,100	6·4	.	.
Other Sheep :—						
One year and above,	981,100	1.002,400			21.300	2·1
Under one year,	2,802,300	2,800,200	2,100	0·1	.	...
Total of Sheep,	6,840.200	6,785.700	54.500	0·8	.	...
Sows kept for Breeding,	24.000	24 500	..	.	500	2·0
Boars being used for Service,	2.700	2,600	100	3·8	.	..
Other Pigs,	170,800	158 900	11.900	7·5	.	...
Total of Pigs,	197,500	186,000	11,500	6·2	...	...

RECENT PERIODICAL LITERATURE.

A number of the following extracts and summaries are taken from recent bulletins of the International Institute of Agriculture. Full references to the bulletins and to the original publications quoted therein may be obtained on application to the Secretary, Board of Agriculture for Scotland, York Buildings, Edinburgh.

Efficiency of Subsoiling. *Journal of the Surveyors' Institution, Vol. III., London*, 1924.—The results are now available of a five years' trial of subsoiling carried out by the Ministry of Agriculture (London) in co-operation with the East Anglian Institute of Agriculture. The soils chosen were London clay, boulder clay, brickearth, sand and gravel. Fields were divided into strips, some of which were ploughed and subsoiled to depths of 5, 7 and 9 inches, and the remainder ploughed only. The subsequent treatment of the plots was identical.

The results have shown that in every case a greater yield has been obtained from the subsoiled plots than from plots which were ploughed only. The maximum increase was 67 per cent. in the case of potatoes, and 50 per cent. increases were frequently obtained. The value of the extra yield, on every occasion, more than paid for the increased cost.

The trials are to be continued for a further 4 years, and new plots are to be laid down in the Oxford area.

Electrochemical Treatment of Seed Wheat. *Leighty, C. E., and Taylor, J. W., Circular* 305, *United States Department of Agriculture, Washington, D.C.*, 1924.—Methods for increasing crop yields by the use of electricity have received attention for many years, one of the most important being that known as the "Wolfryn Process," in which the seeds of crops are subjected to an electric current passing through a conducting solution in which the seed is immersed.

It has been claimed that largely increased yields have been obtained by such treatment, in which the conducting medium was a solution of common salt, and the object of the authors' experiments was to investigate this claim.

Mercier and Fry reported increased gains of 20 to 30 per cent. in cereals, and reduction in losses from bunt, rust and wireworm.

No really critical results are given as the basis for these claims.

Russell reports the results of pot experiments with electrically treated seed at Rothamsted in 1918 and 1919, in which no advantage was shown for seed so treated. In pot experiments with wheat at Oxford an increase of 12 per cent. more grain and slightly less straw was obtained than with untreated seed. In a field experiment carried out by Robb at Wye Agricultural College (Kent) with barley and oats, one variety of oats showed a slight increase, but another variety and barley showed a decrease. Two other trials at Cambridge showed no increase.

Biffen states that: "The trials show no improvement in yields as the result of treatment; there was a small diminution of germinating capacity." Lee in Manitoba, with Marquis wheat on a single-plot test, obtained an increase of 3½ bushels of grain over the control (14·5 : 18·0).

The authors began their experiments in 1920 at the Arlington Experiment Farm in Virginia, using a soft variety of red winter wheat. The grain was pre-soaked for two hours in a 3·5 per cent. solution of common salt, and a current of about 200 watts was passed through the solution for 3½ hours. As controls, a second lot of seed was soaked in a duplicate salted solution for 5½ hours, but without electricity, and a third lot was soaked in water for an equal time. The seed was allowed to dry and was sown two days later. These experiments were repeated in 1921. After a three days' germination test the counts were as follows:—

Water-soaked 88 per cent., electrically treated 84 per cent., salt solution 74 per cent.

Leaf rust (*Puccinia triticina*) was severe in 1921 and 1922, all plots being equally affected.

In 7 out of 8 cases the control plot gave a higher yield than the plot next to it sown with electro-chemically treated seed.

The conclusion drawn from the experiment is that no benefit or profit was shown from treating wheat seed electro-chemically by the so-called "Wolfryn" process.

Investigations into the Changes which occur during the Ensilage of a Green Crop. *Woodman, H. E. (P.D D.Sc.), and Amos, A. (M.A.), Journal of Agricultural Science, Vol. XVI., Part* 1, *Cambridge*, 1924.—It has long been recognised that the type of silage produced is largely determined by the stage of maturity of the crop. In the case of green "fruity" oat and tare silage there is little doubt that its production depends upon ensiling without wilting of an oat and tare crop in the early stages of maturity, when the oats are in milk and the tares between the stages of full flower and half-formed seeds. Experience indicated that if the crop is too immature and succulent the result may be the so-called "sour" silage.

Experience and experiment point to the following generalisations in regard to the influence of the degree of maturity of crop on the quality of silage.

(i.) "Sour" silage results from very immature and succulent crops.
(ii.) Green "fruity" silage from crops in early to medium maturity.
(iii.) "Acid brown" silage from fairly mature crops.

For the experiment a crop of oats, tares and beans was selected; the crop was cut at three different stages of maturity and ensiled quickly. The only varying factor was that of maturity. In no case was the crop damaged by decomposition of the basal foliage.

The crop was cut and ensiled between the following stages:

June 14. Oats just flowered; June 23. Oats at milk stage.
June 30. Oats all in milk. July 12. Glumes changing from green to yellow and grain passing out of milk stage.

The silos were opened on November 7, 14, 21 in the same order as that in which they were filled.

Analysis showed the following differences in losses of dry matter

Maturity of crop.	*Very immature*	*Early maturity.*	*Fully mature.*
% loss of dry matter.	9·7 - 11·8.	8·6 9·0.	5·8

It will be seen that the loss of dry matter decreased as the maturity of the crop increased. These results confirm the earlier finding of the authors that the production of the "acid" type of silage is associated with the least loss.

In the case of oat and tare crops it is now possible to predict the type of silage at the time of filling the silo, and for this reason it is very probable that the undesirable "sour" silage will disappear, and the two kinds which will be made will be green "fruity" and "acid brown" silage.

The results obtained with these two types may be summarised as follows:

	Green "fruity" silage (mean of 8 trials) per cent. gain or loss	"Acid brown" silage (mean of 3 trials) per cent gain or loss
Dry matter	−11·2	− 7·7
Crude protein	− 8·2	0·0
Ether extract	+52·4	+45·0
N-free extractives	−19·1	−14·7
Crude fibre	− 5·5	− 6·0
Ash	− 9·2	0·0
True protein	−41·0	−28·4
"Amides"	+85·3	+96·0

The losses in crude protein and inorganic salts will be noted in the case of "fruity" silage, compared with the "acid brown" variety where they are nil.

Conditions of immaturity seem to favour the splitting up of carbohydrates and true protein.

It may be said that cutting the crop in early to medium maturity in order to make "fruity" silage results in ensiling a smaller weight of forage per acre than if cut at a maturer stage for "acid brown" silage. Against this must be set the fact that green "fruity" silage is superior to "acid brown" in palatability, digestibility and nutritive value. Investigations carried out at Cambridge have shown that the production starch equivalent of 100 lb. of dry matter of green "fruity" oat and tare silage is 45·6, whereas that of "acid brown" oat and tare silage is only 33·4.

Solubility of Limestones as related to their Physical Properties. *Morgan, M. F., and Salter, R. M. Soil Science, Vol. XV. Baltimore, Md.*, 1923.—The authors conclude that with particles of the size ordinarily found in agricultural ground limestones there is no apparent relationship between the rate of solubility in acid soils and any physical property of the rock material. The rate of solubility is very largely influenced by the relative amount of magnesium carbonate in the material. With coarse particles, the decreased solubility may be of considerable significance.

The finer the material is ground, the less important this factor becomes, and with limestone containing 100-mesh material, it is believed that the rate of solubility of dolomitic stones would be sufficiently rapid for all practical purposes.

Effect of Reaction on Legumes and Cereals. *O. C. Bryan. Soil Science, Vol. XV., No 5. Baltimore, Md.*, 1923.—The effects of different reactions on alfalfa, alsike clover and red clover were studied. The results show clearly that the reaction of the media in which the plants were grown has a direct influence on the growth and nodule formation of the plants The reactions which were injurious were within the range of reactions of actual soil solutions and suspensions. Acidity and alkalinity produce toxic effects directly, and also influence the power of the plant to obtain sufficient calcium for normal growth. In general the cereals are less sensitive to acids than to alkalies, and also less sensitive to acids than most of the legumes. It appears that wheat is more sensitive to acid media than oats.

Grasses attacked by Frit Fly. *N. Cunliffe in Ann. App. Biol., Vol. X.*, 1923.—The author has continued the series of careful observations on the habits and prevalence of this common and destructive pest of oat crops which he commenced in 1919 It is now recognised that there are three generations of frit fly in a year, the maximum numbers emerging in spring, mid-summer and late summer. The first two generations deposit their eggs as a rule in oats: the last, occurring when oats no longer provide a suitable rearing ground for the larvæ, lays its eggs about the stems of common grasses. It is important that the grasses most favoured by the *fly* should be determined, for in the destruction of the autumn and winter shelter plants may lie an effective means of checking the pest. This inquiry has been carried out by the author under natural conditions in the field. Of twelve different species of grasses known to be favoured by frit, he found that four species were distinctly preferred for egg-laying purposes. That most frequently infested was false oat, *Arrhenatherum avenaceum*, in which 82·3 plants were attacked. This was closely followed by wall barley, *Hordeum murinum*, with an infestation percentage of 72·5, and slender fox-tail, *Agrestis myosuroides*, with 71·2. Last on the preferred list was Italian rye-grass, *Lolium italicum*, with 52·1. From these species there was a very marked drop in infestation to the next in the series, common rye-grass, *Lolium perenne*, in which the percentage was only 6·7, and it is also remarkable that there should be so great differentiation in susceptibility to frit in two closely related species in the same genus.

Frit Fly and Oats. *N. Cunliffe in Ann Appl. Biol., Vol. XI.*, 1924.—Under natural conditions in spring time the majority of the eggs of the frit fly are found on the lower blades. Later in the season they occur on upper blades, sometimes on the sheaths or even on the haulen just below the soil surface. On emerging the larvæ seek the shelter of the sheath and penetrate to the region of the growing point. The degree of destruction of the central leaf, the

ordinary visible sign of the presence of the pest, depends in part on the accidental path of the borings of the larva, and in part on the state of the plant's development. In the case of damage to grain it was found that the larvæ on hatching generally moved along the groove of the grain, finally penetrating the grain in the region where the sap conducting vessels enter. As soon as these vessels are destroyed by the tunnelling of the larvæ, the food supply of the grain is cut off and the result is a dwarfed or utterly destroyed grain. Should the boring take place before or soon after the ovula is fertilised the larva destroys all parts of the flower, which consequently becomes sterile. From these observations it is safe to conclude that the larvæ show a definite preference for parts of the plant receiving abundant supplies of sap, but what causes the female to deposit her eggs in the suitable positions has not yet been determined.

The continuation of these observations throughout a series of years has led to the conclusion that very diverse weather conditions do not materially affect the seasons when the flies emerge and attack the crop. This may be due to the fact that the larvæ live in safety within the plant stem, and it seems to indicate also that the prevalence of the fly is not entirely dependent on the oat crop, the stages of which depend upon the season, but is determined by the total number of host plants.

Eel-worms and Root-knot. *G. H. Godfrey, U.S. Dept. Agr., Farmers' Bulletin, No.* 1345.—There are several species of eel-worms, microscopically small and almost transparent round or nematode worms, which are involved in crop destruction. Of these the commonest species is *Tylenchus devastator*, but considerable damage is also done by a close relative, *Heterodera radicicola*. The paper under notice refers to the occurrence of this worm in the United States, but since the species is also found in Europe, where it attacks oat-grass and oats, beetroot, lucerne, sainfoin and other crops, something may be learned from the methods of combating the pest practised in America. The parasite attacks the roots of plants, causing swellings variously known as knot-root, root gall and big root. It flourishes best in light, sandy soils which are moist and warm. The great extent of the damage occasionally done is due to the rapid multiplication of the species under favourable circumstances, for each female may lay as many as 500 eggs, and the whole life cycle from egg to egg-laying adult may be completed in four or five weeks In greenhouses the disease may be eliminated by the application in the soil of steam under high pressure, but the problem is more difficult in orchards and fields. In the latter case badly infested trees should be destroyed and the infected soil treated with formaldehyde before replanting. In fields under rotation the most satisfactory course is to plant immune crops for two or three years, at the same time destroying susceptible weeds in which the eel-worm generations may persist. In America amongst immune crops are included barley, rye, timothy, wheat and winter oats. It must be kept in mind, however. that the worms are easily transported from one field to another by running water, by the soil adhering to agricultural implements, to men's boots, and to the hoofs of animals, and this danger must be guarded against. Starving the eel-worms by keeping the land free from all vegetation for two years is an effective control method, but it is seldom that so wasteful a method is practicable.

Cakes, Bone-Meal and Fish-Meal. *I.—Voitellier. Revue de Zootechnie, la Revue des Eleveurs. Year* 3, *No.* 1. *Paris*, 1924. *II.—Hoc, P. Journal d'Agriculture pratique. Year* 87, *Part II. Paris*, 1923. *III.—Poulain, A. La Vie Agricole et Rurale. Year* 13, *Vol. XXIV. Paris*, 1924.—(I).— The continually increasing price of cakes has caused anxiety to various agricultural associations, lest this stock-feed should be replaced by bread-making cereals. This fear is, however, founded on an erroneous idea of the part played by cakes in the rations of animals. If the role of cake in cattle feeding is examined, it will be seen that in the majority of cases it serves to maintain the equilibrium of the daily ration, that is to say it insures the best nutritive relation between the nitrogenous matters on the one hand, and the fats and carbohydrates on the other; thus the rations are utilised to the fullest extent. The author is, therefore, of opinion that as long as the different cakes supply a kg. of nitrogenous matter at a lower cost than that of the cereals harvested on the farm, they should certainly be used as a stock-feed. The ordinary method of estimating this cost is first to find the net cost of the nutritive unit and then to calculate

the price per kg. of the albuminoid substances in the cakes and cereals. All transport, storage, cleaning or delivery costs must be included. For example, the net cost of the food unit in the case of good meadow hay containing 31 food units per cent. and costing at the farm 22 francs per 100 kg. would be 0·78 fr., and as it contains 3·8 per cent. of albuminoid substances, the net cost per kg. of albuminoid matter would amount to 5·78 fr. The author shows that this method has the defect of not closely connecting the two problems, viz., the net price of the food unit and the net price per kg. of the albuminoid substances. Since the object of buying cakes is to narrow the nutritive relation, it is the excess nitrogenous matter in the cakes that is paid for at a higher price. Thus in the opinion of the author it is necessary, in order to get a true estimate, to charge the digestive principles contained in 100 kg. of the foods compared at the rate they would cost when supplied by good meadow hay. The figures thus obtained must be deducted from the price per 100 kg. on the farm, the remainder being divided by the difference between the albuminoid matter content of the hay and of the food in question. In this way, the excess amount of the albuminoids as compared with those in the meadow hay will be obtained. Good meadow hay, price 22 fr. per 100 kg., contains 31 nutritive units (n.u.), thus the unit costs 0·76 fr. Coconut cake contains 76·5 (n.u.), so its hay value would be 76·5 × 0·76 = 55·8. Its price on the market is 76 fr.; hence we have a difference of 76 − 55·84 = 20·16. The difference in the albuminoid content of coconut cake and hay is 12·5 units, which makes the price paid for the larger percentage of albuminoid substances in coconut cake as compared with good hay amount to 20·16 : 12·5 = 1·61. It is clear that the method proposed by the author gives a more exact idea of the relative values of concentrated foods from the moment when their use affects the balance of the rations. The manurial value of the concentrated food used must also be taken into account.

II.—The maximum profit from dairy cows can only be obtained by keeping breeds that are thoroughly adapted to their surroundings, while the animals must be carefully selected, well-cared for and properly fed. The systematic feeding of dairy cows includes feeding special rations that are able to supply during the lactation period the largest amount of nitrogenous matter. A cow weighing 500 kg. and giving 10 litres of milk, should receive 1000 to 1200 gm. protein a day.

It must, however, be observed that the foods grown on the farm are physiologically incapable of supplying a dairy cow with the amount of nitrogenous matter it requires. Cakes are the only supplementary concentrates that can economically make up the deficiency of the nitrogenous substances present in the other elements of the ration. The author after the experiments of MM. Bailly and Benoist of the Department of Agriculture of Eure and Loire has taken pains to prove that, even at the present prices, a good return can be obtained from cakes owing to the large yield produced by their use. Flemish cows of the average weight of 500 kg. were employed in the experiment. The ordinary ration was: straw 8 kg., mangels 36 kg., wheat chaff 4 kg., groundnut cake 1·800 kg., or 1300 gm. digestible protein. The average milk yield attained 7 litres per head and per day. The cows were divided into 2 lots comparable as regards weight, milk yield and date of calving. Lot I. were fed wheat straw 8 kg., chaff 7 kg., mangels 63 kg. Before the experiment, the milk yield of the lot was 29·800 litres; the weight of the cows being 1580 kg. After the first week, the milk yield fell to an average of 24·100 litres, at which it remained throughout the experiment, thus the daily decrease was 5·100 litres. The weight of the animals increased 36 kg. at first, but this was due to the hydration of the tissues caused by the large water content of some of the elements of the ration. The author made a calculation proving clearly that the omission of the cakes (1·800 kg. per day) was shown at the end by a daily loss of 0·65 kg. per head. The experiment was then reversed, the ration being: straw 8 kg., chaff 4 kg., mangels 36 kg., groundnut cake 2·800 kg. Owing to the distant date of calving, the milk yield was not at all affected, but the weight rose from 1609 kg. to 1688 kg., which gave, as the profit from feeding on groundnut cake, the sum of 97·04 fr. Lot II. were fed the same ration as before and an increase in both milk and weight was observable. Later, the cake was left out and the ration was as follows: Straw 8 kg., mangels 63 kg., chaff 7 kg. From the first week a fall in milk yield and weight set in which continued increasing. The author proved that the omission of the cake caused a loss of milk and weight amounting to 90 fr. per head and per month. In Lot III. the cows received

a ration containing a large amount of cake, 2·800 kg. The lactation was not at all affected, but the weight rose 63 kg. A profit of 146·70 fr. per lot was estimated. The examination of the results obtained from Lot III. shows that there is an optimum limit in the use of cakes. The plus-value of the manure, which the author estimates at 10 fr. per head and per month, was not taken into account.

In another experiment, 25 cows were employed The milk obtained was measured during one week; the following week the animals were fed a supplementary ration of 1 kg. of cake per head and per day, with the result that the milk yield was increased 473 litres, giving a monetary profit of 8·55 fr. We may thus conclude with the author that the introduction of cake into the ration immediately proves profitable, and that the partial, or total, suppression of cake is always shown by a decrease of gain.

Studies made in Denmark upon the Average Composition of Cow's Milk, its Fat and Nitrogen Content. *Anderson, A. C., and Laugmack, P. V. F. P., 113te Beretning fra Forsøgalaboratoriet, Copenhagen*, 1923.—The studies under consideration form part of a series of researches for which the Danish delegates made themselves responsible after a Conference held at Stockholm in 1918. The work was begun in the summer of 1919, and lasted for three years. The investigations extended to 34 dairies scattered throughout the country; these establishments undertook to forward once a month, for a period of three years, samples of fresh milk taken according to established rules so that they might be regarded as representative of the average milk sent to the dairy on the day the sample was taken.

The *chief results* of this work may be summarised as follows: the average fat content of the milk from Danish dairies is about 3·5 per cent. The average protein content for the three years may also be given, but the figure can only be approximate, since the proportion of protein has been increasing during the last five years. As we do not know whether this increase has stopped, we cannot take the figures obtained during the last year of the research as being normal About the middle of November, however, the average protein content seemed to vary fairly constantly around 3·3 per cent.: it appears always to be lowest in the months of spring and summer during which growth is regularly most marked. The average content of dry matter freed from fat and protein remains about 5·7 per cent. (the approximate percentage of lactose and ash being 4·8 and 0·8 respectively).

Since the amount of fat and of fat-free and protein-free dry matter remained practically unchanged during the years of the experiment, while the protein content increased continually, it follows that the total dry matter percentage of the milk was rising. At the present time the average amount of dry matter may be estimated at about 12·5 per cent. (rather below than above this figure).

The Minimum Milk Requirement for Calf Raising. *Ragsdale, A. C., and Turner, C. W., Journal of Agricultural Research, Vol. XXVI, No. 9, Washington*, 1923.—Keeping the best calves of dairy breeds with a view to rearing them is one of the most difficult questions on a farm where whole milk is sold. There are two problems that present themselves in this connection: (1) the discovery of an adequate substitute for milk; (2) determining the earliest age at which weaning can be begun. The last point was studied by Fraser and Brand and subsequently by Forman. The results obtained by these workers were such as to encourage the continuation and extension of the researches. In these experiments only pure-bred, or high grade, calves were used; every effort was made to keep them in good condition and as normal as possible in size and weight. The calves were given whole milk until they reached the age of 3 weeks, when the whole milk was gradually replaced by skim milk. Weaning took place at about the end of the second month, the animals being given dry food (without grazing) till they were 6 months old. The 30 calves were divided into two lots, the rations fed were separately weighed for each individual and a note was made of the food which was not eaten, though no attempt was made to limit consumption. Lot I. received soya hay and a concentrated food consisting of 40 parts ground maize + 10 parts wheat bran + 10 parts linseed cake. Lot II. was given: lucerne hay and a concentrate composed of 4 parts of ground maize + 10 parts wheat + 10 parts ground soya-seed (the parts being calculated by weight). At the beginning of

the experiment the calves were weighed 3 days in succession; later they were weighed every 10 days, and the average of the 3 weighings was calculated every 30 days. The height at withers was regarded as giving the increase in height: this measure was taken at the end of the experiment and every 30 days during the course of the experiment. The increased live weight in the case of the calves of Lot I. was 64 per cent. of the normal gain (previously determined by Eckles), while the increase in height was 72 per cent. of the normal increase. In the case of Lot II. the increase in weight was 68 per cent. of the normal and 69 per cent. of the normal in proportion to height. From the point of view of breed, the average gain in height and weight was greater in the Holstein than in the Jersey calves. Further, at the end of the experiment, the Holsteins were in better condition than the Jerseys, for they reached the normal height and weight at the age of 8-9 months, whereas the Jerseys did not attain normal full development before nearly a year. The Holsteins also proved superior to the Jerseys in respect of the weight gained every 10 days. The following table gives some interesting figures showing the amount of food consumed during the experiment:—

TABLE I.—*Average Food Consumption per head.*

Lots.	Milk.	Concentrates.	Hay	Crude digestible protein.	Therms of net energy	Average daily increase in live weight.
	kg	kg	kg.	kg.		gm
I	27·44	193·85	166·17	41·77	527·57	431
II	37·76	205·10	129·22	38·78	516·75	454

TABLE II.—*Food Consumed per kg. of Increase in Live Weight.*

Lots.	Milk.	Concentrates.	Hay.	Crude digestible protein.	Therms of net energy.
	kg	kg.	kg.	kg.	
I.	0·75	3·90	3·24	0·86	10·76
II.	0·85	4·33	2·25	0·77	10·40

About 70 per cent. of normal growth can be obtained by weaning calves at the age of 60-70 days and feeding them with a suitable mixture of concentrates and good quality hay. Once the animals are accustomed to the new diet, they increase further in height and weight. The amount of food consumed is an excellent index of growth.

Milk and Contagious Abortion in Cattle. *Panisset, L., Le Lait, Year* 4, *Vol. IV., No.* 32. *Lyons,* 1924.—Epizootic abortion in cattle is a localised contagious disease due to the presence of large numbers of a specific micro-organism, the *Bacillus abortus* of Bang. The agent of the disease and the troubles it causes are almost entirely confined to the genital organs and their contents during gestation.

The anatomical connections and the physical relations existing between the reproductive system and the udder have suggested that the development of contagious abortion may have some effect upon milk secretion. Intraperitoneal inoculations made in guinea-pigs during the researches conducted for the purpose of discovering the tuberculosis bacillus in commercial milk revealed the presence of special lesions differing from those caused by the bacilli of tuberculosis and not containing any of these micro-organisms which are easily recognised by their number and acid-resistance.

Similar results were obtained from milk taken with every precaution to avoid infection from any other source than the inside of the udder. It was only through the use of a special culture medium, ox-gall, that Schroeder and Cotton succeeded in cultivating and identifying the agent producing these lesions. *Bacillus abortus,* the agent of contagious abortion in cows, is present in apparently healthy animals. Out of 277 milk samples examined, 30 were

found by inoculation to contain the abortion bacillus. During their search for the bacillus in the milk of cows belonging to the same herd, Schroeder and Cotton found 19 out of 140 samples to be virulent; on another farm, 11 out of 36 cows produced milk containing the pathological agent, which, according to Evans, occurs in 23 per cent. of the milk examined. A very interesting fact is the varying persistence with which the bacillus is found in the milk; the latter may be continually or intermittently infected, and may remain virulent only for a very short time or for years. Cows evacuating the bacilli in their milk are healthy to all appearance, but their infected condition can be detected, as blood serum has the property of agglutinating the agent of the disease. The serum has no agglutinating effect if there are no bacilli in the milk; infected milk also has an agglutinating property. The milk is, however, not by any means always virulent, even when the serum test gives positive results and the milk itself is agglutinant. The bacillus of abortion lives in the udder, which is indeed its favourite abode except during the gestation period, as has been proved by experiment.

A goat subjected to intervenous inoculation evacuated these bacilli in its milk 24 hours after the operation; the bacilli continued to pass into the milk for a period of 2 months. Another goat having received a subcutaneous injection was only infectious from the second to the sixth day after the inoculation. Milk has very great power of agglutinating *Bacillus abortus*, the rate of agglutination being 1 in 25 The degree of agglutination varies for the same cow with the quarter from which the milk is taken, the time of milking, the amount of milk secretion and the lactation period. There is no connection between the degree of the agglutination of the milk and the agglutination property of the serum; when the results given by the milk are positive, the serum also gives positive results.

Sometimes the agglutinating power of one quarter is much higher than that of the others, or of the serum. The hindquarters are most commonly attacked. The agglutinating power of the milk may quickly follow the infection of the udder (24 hours after injection), and the agglutinating power of the infected quarter is distinctly higher than that of the other quarters. Colostrum possesses greater agglutinating properties than serum, and is therefore able to produce agglutinating properties that are lacking in a calf even if the latter is the offspring of a diseased dam and has developed in an infected envelope. One hour after the calf has taken the colostrum, its blood becomes agglutinant: cows can be infected through the udder; dirty external surroundings, the countless means of contamination at milking-time, want of clean hands in the milker all may contribute in making the teat a source of propagation of the disease.

As a matter of fact, however, infection by way of the teat is limited and of secondary importance, the favourite path of the bacillus being the digestive canal. Many researches have been made (especially since the establishment of absolute identity of *Bacillus abortus* of cattle and *Micrococcus melitensis*, the agent of Mediterranean fever in man) to discover whether milk coming from cows suffering from contagious abortion is harmful to human beings. The direct inoculation of *Bacillus abortus* has never produced fever or any disturbance in human subjects; the blood cultures remained sterile and, as a rule, no agglutination took place. Therefore since it is well known how readily man is infected by *Micrococcus melitensis* we may safely conclude that *Bacillus abortus* is not an agent producing disease in the human race.

The Sheep Trypanosome and its Transmission. *C. A. Hoare, Parasitology, Vol. XV.*—In 1908 there was described a minute protozoan parasite, *Tryphanosoma melophgium*, which occurs in the blood of sheep in Europe. It is closely related to the cattle trypanosome, *T. theileri*, but as a rule it is rare in sheep's blood, and would appear to produce no ill effects upon its host. In England it has been found by the author of the paper under notice in 80 per cent. of the sheep examined, and its transmission from one individual to another has been shown to be carried out through the agency of the sheep ked. In the gut of this insect the tryphanosome passes through definite stages of development, which end in an infective stage The infection of a sheep does not take place through the biting of the infected ked nor through abrasions of sheep's skin, but is apparently due to contamination caused by the accidental swallowing of keds by the sheep.

Pig-Breeding for the Supply of Special Markets. (Great Britain, New Zealand, Queensland.) *Gorringe, K. W., The New Zealand Journal of Agriculture, Vol. XXVII., No. 4, Wellington,* 1923.—BACON PIGS, SUITABLE CARCASES FOR EXPORT.—The New Zealand pig-breeders have succeeded to a considerable extent in capturing the British market for pork-products and especially for bacon pigs, but as the chief condition of success in this direction is the export of carcases of the desired type, the author describes the characters in request (great length, hams not too large, shoulders moderate in weight, lean and firm, but not stringy, back-fat uniformly distributed, firm, compact, white, and having an average thickness of 4 cm.). He shows how, after the hams and shoulders are removed, the rest of such carcases (viz. all the median part) is well proportioned as regards the successive cuts. The superior meat yield of a bacon carcase as compared with the fat type (very short carcase, back fat excessively thick, etc.) is recognised.

Live weight:	"Bacon" type 84·3 kg.	"Fat" type 43·8 kg.
Dressing yield	" " 63·4 "	" " 56·6 "
Trimmings (not including head and feet) . .	" " 5·4 "	" " 10·2 "

Under the head of trimmings are included all the scraps of meat and fat cut off from the hams, shoulders, etc., in order to balance the weight and render them more shapely for sale. Such small pieces are naturally of very small commercial value. Sometimes, however, although the carcase of the "fat" pig may give a dressing yield 1½ per cent. higher than the "bacon" pig, the latter proves superior in other respects. In fact, although the bacon type appears the heavier, it loses about 8·5 per cent. of its weight as compared with the 18 per cent. lost by the fat type. The hams, while intact, represent 13·5 per cent. of the carcase in the bacon type and 12·8 per cent. in that of the fat type; when trimmed, the percentages were respectively 10·7 and 7·2, thus the meat yield in the case of the bacon type is actually higher.

The author draws attention to the fact that in some districts, where prime bacon carcases are produced, recourse has been had to cross-bred pigs since none of the pure-bred animals could satisfy the requirements. Various means are adopted to obtain the best carcases for export. In Denmark, the country exporting most bacon to Great Britain, the progeny of a Large White boar mated to a native sow are used; in Ireland, a Large White or Large Black (Devon) boar is mated with the Large White native sow, while in Canada a Tamworth boar is generally used to serve Berkshire and Yorkshire sows. In New Zealand, the Department of Agriculture will place at the disposal of breeders the progeny of Large Black and Large White pigs imported direct from England. Good results have already been obtained from the above mentioned crosses (Tamworth × Berkshire and Yorkshire).

The Comparative Value as a Pig-Feed of Fish Meal and other Foods Rich in Albumin. *Annuaire Agricole de la Suisse,* 1923, *Part V.*—Various circumstances have led to the demands for fish-meal which have increased to a remarkable extent in Switzerland during the past year, and since very contradictory opinions are held as to the advantages and disadvantages of feeding this product, it seemed advisable to institute some comparative feeding experiments with fish-meal and other substances containing a high percentage of albuminoids, *e.g.* skimmed and centrifuged milk, meal and sesame cake, linseed and groundnut. The results of 28 analyses of fish-meal recently carried out in Switzerland proved that the samples contained on an average 52 per cent. crude protein, 1·7 per cent. fat, 25·6 per cent. phosphate of lime and 3·3 per cent. salt. These averages hold for the two brands of fish-meal used in the experiments. The tests were conducted on 4 large pig-breeding and pig-fattening farms, the animals being divided into lots each containing 5 to 10 pigs. The experiments lasted 12 to 15 weeks, and in two experiments the animals were observed until the time that they were slaughtered, while the quality of the meat was made the object of detailed study on the part of impartial experts. The foods used in the experiments were given in increasing quantities up to 250 gm. per head and per day; the skim milk was fed in equal quantities as regards its albumin content, viz., up to 3 kg. per day and per pig. The above amounts were consumed without any difficulty by the animals.

It should be mentioned that the skim milk produced a greater increase in

live-weight than the fish-meal. On an average it was found that the lots receiving cake gained practically the same amount of live-weight daily as those given fish-meal.

Neither the dressing-yield nor the analysis of the fat gave any reason for regarding fish-meal as having any bad effect upon the fat or the meat. It must, however, be admitted that for at least 4 weeks before the pigs were killed the fish-meal had been omitted from the rations.

The experiments are not yet finished for, so far, fish-meal has not yet been tested in the capacity of a supplementary food rich in albumin. It is therefore intended to carry out further experiments to enable an opinion to be formed as to the secondary effects attributed to fish-meal, such as for instance its property of stimulating the appetite of live-stock.

The Creation of Industrial Piggeries. *Gouin, R., Revue de Zootechnie, revue des éleveurs, Year* 3, *No.* 1. *Paris*, 1924.—The economic conditions of the industrial production of pork differ essentially according to the circumstances under which the agriculturist is working. In an industrial establishment, where the pig-food is bought in the market, it is easy to calculate the net cost of the ration, while by carefully following the development of the pigs, the second factor necessary for estimating the net price per kg. of pork is obtained. In an industrial piggery it is necessary for this calculation to be made somewhat frequently, in order to be able to determine, by watching the market, the best time to sell so as to obtain the largest profit. The factor of "general expenses" must never be lost sight of; it varies with the farm, although the author fixes it at about 0·40 fr. per head and per day. The daily increase in weight per head should be determined by weighing in order that it may be possible to modify the rations at the right time and to weed out unprofitable individuals. Although the food question is paramount, attention must be paid to hygienic conditions temperature, quiet, cleanliness, punctuality in feeding, all of which may exert a beneficial, or baleful, influence. The author mentions one practical instance: at the Elsesminde Breeding Station, 1 kg. increase in live-weight is obtained by feeding 3 kg. of barley, whereas on a farm 4 or even 5 kg. (in winter) are needed to obtain this weight. These details are of special importance in an industrial piggery on account of the number of animals kept and the value of the food used.

The chief point to be aimed at is a system of feeding calculated to supply the organism with all food elements it needs for reaching maximum development in the shortest time, and at least cost. It is necessary to diminish the risk of loss by the use of varied foods. The author mentions the favourable effect of a narrow nutritive ration in rearing and fattening swine. In industrial piggeries, the daily rations must be calculated according to tables so as to avoid waste. The author calculates the rations as follows: (1) an estimate is made of the digestive protein necessary for the development of the tissues; (2) the food value is calculated in starch required for the production of energy, heat and the formation of the fat deposits. By adding 1 and 2, the amount of the ration is found. As soon as this has been estimated, it is tested; here the skill of the breeder is shown, for he must know how to modify the ration according to individual requirements, and interpret judiciously the results obtained. Only one change must be made in each trial, after which the original ration is fed again, the increased requirements being taken into account, and the individual peculiarities eliminated by using a large number of animals.

One of the most favourable conditions for starting an industrial piggery is to have at its disposal a considerable amount of waste products of animal origin, but these must not be too freely used. The author has obtained 600 gm. increase in live-weight daily from feeding the following mixture to swine weighing 50 kg., 1·500 kg. tripe and 1·500 kg. ground ryes. This mixture is given cooked. In place of rye, maize, sorghum and potatoes may be used. When blood is given, it must be collected while fresh and clean, and fed after cooking, otherwise enteritis may be produced. To these rations should frequently be added green, chopped forage in order to provide the vitamines that are indispensable. Therefore it is necessary to give careful consideration to the price of these foods and to make estimates so as to have the pigs ready for sale when a balance between the cost price and the price per kg. is reached. It generally pays best to sell the pigs at as early an age as possible, provided

the prices are equal, but the state of the market must be kept in view. A last question to be considered is the age at which it is best to buy porkers for fattening.

As the net cost per kg. is lowest in the youngest animals, advantage must be taken of the first months when the margin of profit is greatest. As a rule, however, it is not advisable to choose piglings when just weaned unless there is a large quantity of whey at disposal, since such young animals are more liable than others to rachitis and that much dreaded disease, pneumo-enteritis. Older pigs generally give a more satisfactory economic balance. To sum up: if an industrial piggery is to prove highly profitable, the different problems that arise must be solved by calculation.

Poultry-Feeding Experiments and Laying Control. I. *Hofman, Bang N. O. Beretning fra Forsöglaboratoriet, No.* 112. *Copenhagen,* 1923. II. *Holm, R. Nolge. Ibidem, No.* 112. *Copenhagen,* 1923.—I. *Poultry-feeding experiments.*—These experiments were conducted at two different places, Lundsgaard and Trollesminde, under favourable conditions. At Lundsgaard the birds used included fowls that had been reared on the farm and also others that had been purchased, while in the Trollesminde experiments all the hens had been raised on the premises. Fowls of one and of two years old respectively were employed in these feeding experiments. The birds were divided into different lots according to their weight and origin, while the hens of each breeder were put into different groups. Where birds of two years old were employed whose laying during their first year was known, care was taken that the hens of different laying capacity were distributed among the different lots. In the same way, the amount of food fed the birds during the first year was taken into account. The egg-laying control was carried out by means of trap nests. The eggs of each group of hens were weighed daily, but no record was made of the weight of the eggs laid by the individual birds. During the first years the experiments lasted for 12 months; subsequently, the experiment year was limited to 11 months, because the month of November, when egg-yield was lowest, had been selected as the time for thoroughly cleaning and disinfecting the fowl-houses.

The feeding experiments were directed to several different questions:

(1) More or less liberal feeding:

(*a*) limited rations, more or less liberally fed,

(*b*) limited rations and food placed at the free disposal of the birds.

(2) Comparison between cereals and potatoes.

(3) Green food and no green food.

The chief results of the above-mentioned feeding experiments were as follows:—

(1) Increasing the daily ration from 87·5 gm. to 105 gm. per hen increased the number and average weight of the eggs. It is impossible to say how much food is habitually required by fowls, for this depends upon the laying capacity of the birds and also on other factors.

(2) If hens are given free access to a dry, ground food, they lay larger and more eggs than if they are given limited food rations. Free feeding does not make the hens fat, and is an easy method to adopt.

(3) Even if cereals are replaced by a treble weight of boiled potatoes, hens fed on potatoes produce smaller eggs than those given cereals.

(4) Including a liberal supply of green food in the rations causes the hens to lay earlier and produce more and larger eggs than can be obtained in the absence of green food. Lack of the green food is injurious to the health of the birds, especially to that of hens that are one year old.

II. *Some experiments resulting from the egg control carried out at Lundsgaard in* 1915-21.—Some years ago a fowl-house was built at Lundsgaard where the Danmarks Fjerkreavler-forening (Members of the Poultry Breeders' Society of Denmark) could have 20 lots of hens each of 6 birds controlled annually. The testing was carried out by means of laboratory experiments, and upon young birds; it only lasted 11 months, as one month was needed for the clearing and disinfection of the hen-house.

After working up the material, E. Holm found the chief results to be as follows:

(1) It may be taken as a general rule that pullets which begin laying early will produce more eggs the first year than those which begin laying late.

(2) Young hens laying many eggs in the winter usually lay many eggs in the summer.

(3) If the chicks have been properly reared at the right season, it is generally advisable to weed out all the pullets that have not produced eggs before March 1. This allows the least fertile hens to be eliminated from the breeding stock.

(4) Pullets increase in weight up to March 1, after which their weight falls during the spring months, to rise again in the course of the summer and autumn.

(5) At Lundsgaard the large fowls ate more of the food fed *ad lib.* than the smaller birds consumed, but without producing a greater weight of eggs.

Sexual Hormones and their Specific Action upon the Organism. *Cosmao, G., Le Revue de Zootechnie, la Revue des éleveurs, Year* 3, *No.* 3. *Paris*, 1924.—Among the internal secretory glands known as vascular, or endocrinic, are classed the sexual glands, which by pouring their products of secretion into the blood exert a distinct influence on certain sexual characters. In this connection the author mentions the researches conducted by M. Pézard, Director of the work of the Laboratory of General Biology at the *Ecole des Hautes Études.* The subjects selected for these experiments were Gallinaceae, since in these birds sexual dimorphism is very clearly marked. These dimorphic characters are known as secondary sexual characters. The first question studied was whether these secondary sexual characters are an integral part of the bird or depend on the presence of the sexual gland and are affected by chemical product of this gland. A buff Leghorn cockerel was castrated at the age of 4 months; this bird developed no comb or wattles, and was free from combative instinct; it did not crow, although its plumage and spurs appeared normal. On the other hand, a hen that had been subjected to ovariotomy developed spurs, while its plumage changed shortly afterwards to such an extent that the bird looked exactly like a cock with a small comb. The development and turgescence of the comb and wattles, the power of crowing and the combative instinct are therefore all characters depending on the internal secretion of the testicles; the plumage and spurs are not properly speaking male characters since they are latent in the female and are only prevented from making their appearance by the inhibitory action of the ovary. It was thus demonstrated that secondary sexual characters are dependent positively, or negatively, upon the reproductive glands. It, however, still remained to find out whether this physiological correlation was established by way of the nerves or the endocrine glands

Some pieces of testicle were grafted into the peritoneum of a capon with the result that its comb began to grow again and the combative instinct returned. A fragment of ovary was grafted on a hen from which the ovary had been removed and forthwith the spurs stopped growing. Since the characters lost by de-sexed birds reappear immediately as a result of the grafting of portions of sexual glands, even in places far from the position assigned to them by nature, it is certain that the correlation between these sexual characters and the glands is established along an endocrinal, humoral path and not by way of the nerves.

These transplantation experiments have shown the impossibility of obtaining stable intermediate forms between the neuter and the normal sexual form (M. Pézard's law of "all or nothing"). It was also proved that there exists an "effective minimum" of the amount of the sexual gland to be transplanted in order to renew the characters lost by castration; above this minimum the renewal takes place with the same intensity and rapidity no matter how much of the gland is transplanted ("law of functional constancy"). The last point to be explained was the "equipotentiality," viz., the power of evolution in the direction of the male form as well as in that of the female form; it is now possible to make the cock or the hen develop in the direction opposite to that of its original sexuality. A Leghorn cock castrated at the age of 1½ years assumed, after a small piece of ovary had been grafted on it, all the external characters of a Leghorn hen. This explains many anomalies which have hitherto remained most mysterious. The theory of sexual hormones may be summarised as follows: (1) A correlation exists between the sexual glands and the development of sexual characters; (2) this correlation is effected by humoral mechanism along an endocrinic route, and not by way of the nerves; (3) the same potentiality exists in both the male and the female.

Physiological Studies on Apples in Storage. *Magness, J. R., and Diehl, H. C., Journal of Agricultural Research, Vol. XXVII., No. 1, Washington, D.C.,* 1924.—Observations on the physiological changes in the apples during the process of ripening on the tree:—increase in size, changes in colour, texture and acid content, etc.—are factors all closely associated with storage quality. The authors review the subsequent changes which occur after picking, and study the effect of storage conditions, packing, ventilation and temperature relative to acidity, loss of moisture and weight. Coating the fruit with paraffin or oil results in a slower rate of softening, and respiration tests were made at different temperatures. Concentration of carbon dioxide up to the rate of 2-3 per cent. has no deleterious effect on the fruit, and will retard softening. A high concentration will, however, hinder ripening.

United States. *Crop Production per Capita.*—Falling crop production in relation to the population is indicated by comparisons made by the U.S. Department of Agriculture. The average mass of crop production for 1910-1914 being regarded as represented by 100, the average for the five years 1915-1919 was 99·6, for the four years 1920-23 95·2, and 1923 has a relative standing of 93·0. Decline began after 1895-1899. Before that period there was increase *per capita* since 1890, when the Department's comparisons began.

These results are determined by index numbers of crop production, based on the combined production of 10 crops (maize, wheat, oats, barley, rye, buckwheat, potatoes, hay, tobacco and cotton), which have more than 95 per cent. of the total acreage of all crops, and therefore represent the changes in total production. The following index numbers of total production are obtained by applying a constant average price to the yearly production of each crop: 1890-1894, 62·0—1895-1899, 78·0—1900-1904, 84·5—1905-1909, 94·0—1910-1914, 100—1915-1919, 108·0—1920-1923 (4 years), 109·0—1923, 109·0. The basis, or 100, is the average for the five pre-war years 1910-1914.—(*Crops and Markets, U.S. Dept. Agric., Vol.* 1, *Supplement No.* 2, *February* 1924.)

Poultry Breeding.—This has made rapid progress and in 1923 the produce was valued at 1019 million dollars, *i.e.*, about 17 per cent. of the total animal products. The industry is the furthest developed between the Mississippi river and the Rocky Mountains, and between Oklahoma and Canada. The estimated value for egg produce in 1923 was 599 million dollars and for fowls 420 million dollars. The number of hens on the farms in January 1924 is estimated at 474,500,000.—(*Crops and Markets, U.S. Department of Agriculture, Vol.* 1, *No.* 1, *Supplement No.* 2, *Washington, Feb.* 1924.)

The Suppression of the House-Fly. *L. O. Howard and F. C. Bishopp, U.S. Dept. Agr., Farmers' Bull.* 1408, *Ap.* 1924 The common house fly is an unhealthy companion, for it has been known to carry the germs of typhoid, Asiatic cholera, dysentery, enteritis and infantile diarrhœa, and with them to infect healthy persons, and there are other diseases in connection with the spread of which flies lie under strong suspicion. But apart from that, the actual presence of flies is annoying, and the filth they deposit upon human food and human goods of all kinds is enough to condemn them. More than the flies are to be condemned in such cases, for the unusual presence of flies is an indication of uncleanness, insanitary conditions, and improper disposal of substances in which they breed. Of these the manure heap is probably the worst. The pamphlet mentioned deals largely with methods of preventing the establishment of the manure heap as a fly-breeding centre, and offers some excellent advice. Thus in towns, where flies are most dangerous to human beings, manure should be removed twice a week, since the fly larva reaches the migratory stage after three days, and may leave the heap to shelter in neighbouring crevices or in the soil. In some American areas such removal is compulsory under orders of their health authorities. In country farms, where, owing to larger stocks, the accumulation of manure is, as a rule, more rapid, the problem becomes more difficult. Here the manure heap may be sprayed or dusted with poison of various sorts, such as powdered hellebore—the poison best suited for the purpose—or with powdered borax, or calcium cyanide and acid phosphate, which has the advantage of increasing the fertilising quality of the manure by adding nitrogen and phosphorus. A horse manure fly-trap has also been found to do good work. The trap consists of a concrete basin, which is filled with water, and over which is built a slatted platform. On

this platform the manure is placed, and the maggots as they bore downwards when the time for pupation approaches, finally fall through the slats into the water reservoir and are drowned. It is said that this very simple arrangement will account for 99 per cent. of all the maggots breeding in a given lot of manure.

The Destruction of Cupboard Pests. *P. Mitchell, Health, Melbourne,* 1924.--One of the familiar pests of store cupboards in dwelling-houses is the tiny, torpedo-shaped, glistening insect which scuttles rapidly to cover when the door is opened - the "silver fish" or *Lepisma*. It probably does very little harm, for, though it has been accused of nibbling paper, it feeds chiefly upon sugar and bread stuffs. The "silver fish" has recently been the object of some tests made in Australia to determine how best to get rid of it, and among other things the effects of the largely used substance, naphthaline, were contrasted with those of magnesium sulphate crystals. It was found that at the close of five months the cupboards protected by naphthaline were badly infested by *Lepisma* and that the chemical itself had deteriorated; whereas the cupboards in which the magnesium sulphate crystals had been sprinkled remained free from the insects and the chemical had only slightly deteriorated at the end of a year. Founding upon his experiments, the author is of opinion that against such pests as moths and cockroaches, as well as for *Lepisma*, magnesium sulphate is of greater effect than naphthaline; but it must be noted that it can be used effectively only in closed presses, cupboards or boxes, on account of the rapid deterioration to which it is liable when exposed freely to the air.

STATISTICS.

PRICES of AGRICULTURAL PRODUCE and FEEDING STUFFS in June, July and August 1924.

AVERAGE PRICES OF LIVE STOCK IN SCOTLAND.

(Compiled from Reports received from the Board's Market Reporters.)

Description.	June.			July.			August.		
	1st.	2nd.	3rd.	1st.	2nd.	3rd.	1st.	2nd.	3rd.
FAT STOCK:—									
CATTLE—	per cwt. l.w. s. d.	per cwt. l.w. s. d.	per cwt. l.w. s. d.	per cwt. l.w. s. d.	per cwt. l.w. s. d.	per cwt. l.w. s. d.	per cwt l.w. s. d.	per cwt. l.w s. d.	per cwt. l.w. s. d.
Aberdeen-Angus ...	70 4	64 8	46 0	73 3	66 10	48 11	71 1	64 8	47 9
Cross-bred (Shorthorn)	67 4	61 11	44 3	68 8	63 0	44 8	66 3	60 4	42 10
Galloway	70 8	64 9	...	66 0	60 0	..	61 8	56 8	...
Ayrshire	59 9	51 9	37 6	65 0	57 5	41 2	61 10	55 3	39 0
Blue Grey	.	..	..	...	. .		...	...	.
Highland	...	..	...	71 0	.	. .	66 0	...	...
	per lb. d.	per lb. d.	per lb. d.	per lb d.	per lb. d.	per lb. d.	per lb. d.	per lb. d.	per lb. d.
VEAL CALVES	18¾	9¼	6¾	13¾	7½	5½	13	6½	5½
SHEEP—	under 60 lb. per lb. d.	60 lb. and upw'ds. per lb. d.	Ewes per lb. d.	under 60 lb. per lb. d.	60 lb. and upw'ds per lb. d.	Ewes per lb. d.	under 60 lb. per lb. d.	60 lb. and upw'ds. per lb. d.	Ewes per lb. d.
Cheviot	19¼	18½	14	19½	18½	14¼	18½	17¾	13¾
Half-bred	18¼	17¾	12½	18½	17¾	12¼	18	17¼	12
Blackface ..	18¾	17¾	13½	18¾	17½	13½	18½	17	13½
Greyface . .	18¾	17¾	10¾	18¾	17¾	9¼	18¼	17½	9¾
Down Cross	19	18¼	...	18¾	17¾	...	18½	17½	...
PIGS—	per stone. s. d.	per stone. s. d.	per stone. s. d.	per stone. s. d	per stone. s. d.	per stone. s. d.	per stone. s. d.	per stone. s. d.	per stone. s. d.
Bacon Pigs	10 7	9 1	...	10 8	9 3	...	10 10	9 2	.
Porkers	10 11	9 10	...	10 11	9 7	..	11 0	9 7	...

AVERAGE PRICES OF LIVE STOCK IN SCOTLAND—*continued.*

Description.	June. 1st.	June. 2nd.	June. 3rd.	July. 1st.	July. 2nd.	July. 3rd.	August. 1st.	August. 2nd.	August. 3rd.
STORE STOCK:—									
STORE CATTLE—	Per head.	Per head.	Per head.	Per head.	Per head.	Per head.	Per head.	Per head.	Per head.
Aberdeen-Angus:	£ s.	£ s.	£ s.	£ s.	£ s.	£ s.	£ s.	£ s.	£ s.
Yearlings ..	20 8	16 11	13 1	19 13	16 19	13 4	19 5	16 6	14 2
Two-year-olds	27 4	23 7	18 15	27 3	23 9	18 11	27 5	23 3	...
Cross-bred (Shorthorn):									
Yearlings ...	18 9	15 7	12 11	18 7	15 13	12 17	17 16	15 6	12 12
Two-year-olds ...	25 13	21 15	18 7	25 10	20 6	18 5	25 9	20 19	18 6
Galloway:									
Yearlings ...	16 3	...	...	16 11	..	...	...	13 10	..
Two-year-olds ..	29 3	22 18	..	29 5	20 10	.	...	22 0	..
Ayrshire:									
Yearlings ...	13 5	...	.	12 5	10 5	..	..	...	...
Two-year-olds ...	.	...	.		17 15	14 0	.	..	.
Blue Grey:									
Yearlings ...		.	.		.	..	...	.	..
Two-year-olds	.		.	..	.	.		...	...
Highland:									
Yearlings ..	11 11	9 18	8 8	10 0	8 4	6 5	11 5	9 8	7 0
Two-year-olds ..	18 6	15 0	12 18	15 6	13 5	11 9	15 13	12 15	10 14
Three-year-olds ..	22 18	19 13	18 15	18 10	15 18	.	.	..	
DAIRY COWS—									
Ayrshire:									
In Milk ...	31 12	23 11	15 18	35 1	26 15	17 1	36 14	27 13	16 10
Calvers ...	33 4	24 15	17 3	34 6	26 7	17 18	37 0	27 4	17 8
Shorthorn Crosses:									
In Milk ...	39 10	30 5	20 10	40 4	30 1	20 18	40 9	31 12	22 11
Calvers ..	36 8	28 13	19 19	37 0	28 2	19 19	40 4	30 9	21 17
STORE SHEEP—	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.
Cheviot Hoggs ...	62 9	53 1	44 1	62 9	49 0	48 0	69 8	52 6	...
Half-bred Hoggs ...	78 10	67 7	59 6	...	69 5	61 0	79 6	..	60 0
Blackface Hoggs ...	53 11	41 5	33 11	43 1	34 4	27 6	50 6	40 1	26 6
Greyface Hoggs ...	80 6	65 8	55 0	73 4	59 7	45 0	70 5	61 2	58 9
Down Cross Hoggs	...	...	...	...	...	...	...	...	...
STORE PIGS—									
(6 to 10 weeks old)	31 3	19 6	...	29 11	18 7	..	26 1	17 0	...

Average Prices of Dead Meat at Dundee, Edinburgh, and Glasgow.

(Compiled from Reports received from the Board's Market Reporters.)

Description.	Quality.	June. Dundee.	June. Edinburgh.	June. Glasgow.	July. Dundee.	July. Edinburgh.	July. Glasgow.	August. Dundee.	August. Edinburgh.	August. Glasgow.
		per lb. d.	per lb. d.	per lb. d.	per lb. d.	per lb. d.	per lb d.	per lb. d.	per lb. d.	per lb. d.
Beef :—										
Home-fed—										
Bullock or Heifer .	1	10¾	10⅞	11⅞	11	11⅜	12¼	10¼	11	11⅝
	2	10¼	9⅞	10¾	10½	10	10⅞	9⅞	9¾	11
Bull . .	1	9⅜	9¼	9⅛	9½	9⅛	9	8¾	8⅞	8¾
	2	8⅞	8⅜	8⅛	9	8¼	8	8¼	8⅛	7½
Cow	1	7½	7¼	9¼	7⅝	7⅛	8⅞	6⅝	7	7¾
	2	7	6½	7½	7⅛	6¼	6⅝	6¼	6¼	5⅝
Irish—										
Bullock or Heifer	1	...	.	11	.	...	11	..	.	10⅝
	2	...	...	10⅜	.	..	10	..	..	8¾
Bull	1	.	..	8⅜		...	7⅞	..		7⅛
	2	...	..	7⅜	...	..	6⅞	...		6½
United States & Canadian—										
Killed at Birkenhead	1		..	...	...	..	9¾	..	..	..
	2	...	...	...	.	.	9½	..	.	..
,, Glasgow	1	...	...	10⅞	..	..	..	..	.	10½
	2	...	...	10¼	.	..	..	..		9⅜
Argentine Frozen—										
Hind Quarters .	1	.	6⅛	..	..	5¼	..	..	5¾	
	2		..		..		...	.	4¾	...
Fore ,, ...	1	.	3½			3	..	.	3⅛	
	2	...	..	.	.	..	..			..
Argentine Chilled—										
Hind Quarters ...	1	..	6⅝	6½	..	5¾	6¼		7	7½
	2	.	..	6⅛		5½	5⅛	.	5¾	6⅝
Fore ,, ...	1	.	3⅜	3⅜	..	3	3		3⅜	3⅜
	2			3⅛	.	2½	2½		2¾	3¼
Australian Frozen—										
Hind Quarters	1	.	...	6			5½	..	...	6⅛
Fore ,,	1	..	..	3¾	..	...	3	..	..	3⅛
Mutton :—										
Hoggs, Blackface .	under 60 lb.	18½	16¼	17½	19¼	16¼	17⅜	17½	15½	17
	60 lb. & over	17	15⅛	16⅛	18¾	15	15⅞	..	14½	15½
,, Cross .	under 60 lb	18½	16¾	17½	19¼	16⅝	17⅜	17½	16	17
	60 lb. & over	17	15⅛	16	18¾	15⅜	15⅞	..	15	15⅛
Ewes, Cheviot	1	13¾	11½	14⅛	13¾	11	13⅞	12½	10¾	12⅝
	2	12¾	.	13⅜	13	..	12⅞	.	...	11½
,, Blackface .	1	13¾	...	14⅛	14¼	...	12⅞	12½	...	12
	2	12¾	...	12½	13	...	11⅞	...	...	10⅜
,, Cross ...	1	9¾	10⅝	9⅞	10	9⅞	9⅜	9¼	9⅞	9⅛
	2	8¾	...	7⅞	9	...	7⅜	8¼	...	7¼
Argentine Frozen ...	1	...	6½	6½	...	6½	6½	...	7¼	7¼
	2	...	...	...	...	..	...	..	...	...
Australian ,, .	1	...	..	6	..	...	6	.	.	6½
	2	...	...	5½	...	...	5½	.	...	...
New Zealand ,, ..	1	..	...	...	...	...	...	...	...	..
	2	..	...	...	...	..	...	...	...	...
Lamb :—										
Home-fed . .	1	20	18½	19¾	19¼	18⅛	19⅜	17½	16¼	17¾
	2	...	16	18¼	...	...	17⅜	...	14½	15
New Zealand Frozen ...	1	...	11⅞	11½	...	11½	11½	...	12⅛	11⅞
	2	...	...	10⅞	...	...	10½	...	...	11¼
Australian ,, ..	1	...	...	10½	..	...	10½	...	...	10⅞
	2	...	...	9½	...	..	9½	...	...	9½
Argentine ,, ..	1	...	9¼	9¼	...	...	9¼	...	9⅞	9¾
	2	...	...	...	...	...	...	...	...	...

(Compiled from Reports received from the Board's Market Reporter.)

Description.	Quality.	June.	July.	August.
BUTTER:		s. d.	s. d.	s. d.
Irish Creamery ... per cwt.	1	178 0	196 0	200 0
" " (Unsalted) "	1	189 6	199 7	204 0
Danish ... ... "	1	189 0	205 2	219 6
" (Unsalted) "	1	198 6	215 0	229 6
New Zealand ... ... "	1	183 6	198 5	211 6
CHEESE:				
Cheddar ... ... "	1	93 0	102 0	109 6
	2	...	96 10	101 6
Dunlop ... ... "	1	82 0	93 7	94 6
	2	78 0	88 10	90 0
Canadian ... ... "	1	105 6	102 10	104 0
" ... ... "	1	91 0*	95 7*	96 8*
New Zealand (Coloured) "	1	96 3	99 2	98 6
" (White) "	1	95 9	102 0	103 6
BACON:				
Ayrshire (Rolled) ... "	1	146 0	143 7	149 3
Irish (Green) ... ... "	1	...	...	...
" (Dried or Smoked) "	1	142 0	131 5	141 9
" (Long Clear) ... "	1	130 6	124 5	138 6
Wiltshire (Green) ... "	1	...	...	...
" (Dried or Smoked) "	1	...	...	...
American, Long Clear Middles (Green) "	1	82 6	90 10	100 6
American, Short Clear Backs ... "	1	87 6	96 0	98 6
American, Bellies ... "	1	89 0	93 7	94 0
" Sides ... "	1	...	...	...
" Cumberland Cut "	1	75 0	83 2	101 0
Canadian, Sides ... "	1	90 6	93 7	106 6
Danish, Sides ... ... "	1	107 3	112 0	117 0

Description.	Quality.	June.	July.	August.
HAMS:		s. d.	s. d.	s. d.
Irish (Smoked) per cwt.	1	211 0	199 10	194 0
American Long Cut (Green) ... ... "	1	90 0	96 5	103 6
	2	86 6	92 2	99 6
American, Short Cut "	1	89 3	96 10	100 6
	2	87 6	93 2	97 0
Canadian, Long Cut "	1	...	...	...
EGGS:				
Country . per doz.	1	1 6	1 9	2 1
	2	1 4	1 7	1 11
Irish ... .. per 120	1	13 8	16 5	17 3
	2	12 11	15 11	16 6
" (Duck) .. "	1	12 10	14 0	15 9
	2	12 3	...	14 0
Chinese... ... "	1	...	13 8	13 9
	2	...	12 8	12 9
Danish ... .. "	1	16 0	18 3	18 2
	2	14 9	16 8	16 11
Dutch .. ... "	1	...	17 0	16 7
	2	...	...	...
Polish ... .. "	1	11 2	12 11	14 5
	2	10 5	10 9	13 2
Russian ... "	1	10 5	11 10	12 6
	2	9 6	11 3	11 9

* New Cheese

AVERAGE PRICES OF POTATOES AT DUNDEE, EDINBURGH, AND GLASGOW.

(Compiled from Reports received from the Board's Market Reporters.)

Market.	Quality.	First Earlies.	Second Earlies.	Late Varieties. Red Soils. Langworthy and Golden Wonder.	Late Varieties. Red Soils. Other.	Late Varieties. Other Soils. Langworthy and Golden Wonder.	Late Varieties. Other Soils. Other.
		per ton. £ s. d.	per ton. £ s. d.	per ton. £ s. d.	per ton. £ s. d.	per ton. £ s. d.	per ton. £ s. d.
JUNE.							
Dundee ...	1	...	...	...	...	14 10 0	14 0 0
	2	...	...	...	...	...	...
Edinburgh ...	1	...	...	...	...	16 0 0	15 8 0
	2	...	...	...	...	...	...
Glasgow ...	1	...	...	15 5 0	...	15 2 0	14 5 0
	2	...	...	...	...	...	...
JULY.							
Dundee ...	1	13 4 0	...	...	...	...	...
	2	8 5 0	...	...	...	...	...
Edinburgh ...	1	9 16 0	...	...	...	...	...
	2	...	...	...	...	...	...
Glasgow ...	1	16 1 0	...	...	...	...	16 0 0
	2	...	...	...	...	...	...
AUGUST.							
Dundee ...	1	5 6 0	...	...	...	...	...
	2	...	...	...	...	...	...
Edinburgh ...	1	5 0 0	5 0 0	...	...	...	...
	2	...	...	...	...	...	...
Glasgow ...	1	5 17 0	5 17 0	...	...	...	...
	2	...	...	...	...	...	...

Average Prices of Roots, Hay, Straw, and Moss Litter, at Dundee, Edinburgh, and Glasgow.

(Compiled from Reports received from the Board's Market Reporters.)

Market.	Quality.	Roots.			Hay.		Straw.			Moss Litter.
		Carrots.	Yellow Turnips.	Swedes.	Rye Grass and Clover.	Timothy.	Wheat.	Barley.	Oat.	
		per ton. s. d.	per ton. s. d.	per ton. s. d.	per ton. s. d.	per ton. s. d.	per ton. s. d.	per ton. s. d.	per ton. s. d.	per ton. s. d.
					JUNE.					
† Dundee ...	1	...	...	30 0	130 0	...	85 0	85 0	90 0	46 0*
	2	...	...	...	121 11‡	...	...	...	...	...
‡ Edinburgh	1	...	...	...	117 6	...	61 3	60 0	61 11	45 0§
	1	...	...	...	...	...	...	...	...	40 0**
‖ Glasgow ...	1	...	...	...	110 0	110 0	60 0	40 0	68 9	39 5
	2	...	...	...	...	...	...	...	...	...
					JULY.					
† Dundee ...	1	...	...	...	130 0	...	90 0	90 0	93 0	46 5*
	2	...	...	...	120 0‡	...	...	...	...	...
‡ Edinburgh	1	...	...	...	120 6	...	65 6	...	62 0	45 0§
	1	...	...	...	70 0††	...	...	...	...	40 0**
‖ Glasgow ...	1	...	...	...	110 0	110 0	60 0	40 0	65 0	37 6
	2	...	...	...	...	...	...	...	...	...
					AUGUST.					
† Dundee ...	1	...	...	...	130 0	...	91 3	90 0	91 3	36 6*
	2	...	...	...	...	...	...	...	...	...
‡ Edinburgh	1	...	...	...	66 10††	...	70 0	...	68 2	45 0§
	1	...	...	...	...	...	...	...	...	40 0**
‖ Glasgow ...	1	...	...	...	110 0	110 0	60 0	40 0	65 0	37 6
	2	...	...	...	...	...	...	...	...	...

† Quotations for Hay and Straw, baled and delivered. * At Quay.
‡ " " " delivered loose in town. § Dutch.
‖ " Baled Hay and Straw, f.o.r. ** Home. †† New Crop.

Average Prices of Feeding Stuffs at Glasgow and Leith.

(Compiled from Reports received from the Board's Market Reporters.)

Description.	June.						July.						August.					
	Glasgow.			Leith.			Glasgow.			Leith.			Glasgow.			Leith.		
	per ton. £	s.	d.	per ton. £	s.	d.	per ton. £	s.	d.	per ton. £	s.	d.	per ton. £	s.	d.	per ton. £	s.	d.
Linseed Cake—																		
Home	12	0	0	11	10	0	12	8	9	12	1	0	13	10	0	13	0	0
Foreign	11	6	3	10	10	0	12	0	0		...		13	5	0		...	
Soya Bean Cake ..	*10	17	6		..		*11	0	0		...			...			...	
Decorticated Cotton Cake	13	15	0		...		13	15	0		...		14	5	0		..	
Undecorticated Cotton Cake—																		
Bombay (Home-manufactured)...	7	8	2	7	6	3	7	7	6	7	8	6	8	3	9	7	18	9
Egyptian (Home-manufactured ..	8	8	2		...		8	13	0		...		9	3	9		..	
Coconut Cake ..	10	12	6		...			...			...			..			...	
Palmnut Kernel Cake	8	15	0		...		8	10	0		.		9	3	9		...	
Groundnut Cake— Undecorticated ..		...			...			.			.		10	15	0		.	
Maize Germ Cake—																		
Home ..	10	16	3		..		10	10	0		..		11	6	8		.	
Foreign	10	10	0		...		10	16	0				11	0	0		.	
Maize Germ Cake Meal . ..	10	10	0		.		10	14	0		..		11	18	9		..	
Bean Meal	†12	5	0	11	15	0	12	18	4	11	15	0	13	1	3	11	10	0
Maize Meal ...	11	0	0	11	10	0	**11	0	0	10	1	0	**10	15	0	10	10	0
Rice Meal . ..	8	0	0		.						...			...			...	
Locust Bean Meal ...	8	10	0	8	0	0	8	12	6	8	9	6	8	7	6	8	8	9
Locust Beans (Kibbled and Stoned)		...		7	0	0		..		7	7	0		...		7	10	0
Maize Gluten Feed (Paisley) ...	9	11	3		..		9	11	0		...		10	0	0		.	
Maize	‡10	14	5	10	5	0	‡10	6	0	9	1	0	‡10	10	0	9	10	0
Oats, Canadian—																		
,, ,, (No. 2 Feeds)	9	7	6		..		9	15	0		..		10	13	2		...	
,, ,, (No. 3 Western)	9	2	6		.		9	5	10		..		10	7	6		..	
,, Plate	7	15	0		..		8	7	0		...		9	3	2		.	
,, Home ...	10	10	0	10	0	0	11	5	0	10	0	0	12	2	6	10	5	0
Barley (Feeding) ...	11	0	0	10	0	0	10	6	8	10	0	0	11	10	0		..	
Malt Culms... ..	6	16	8	5	10	0	6	13	4	5	10	0	6	17	6	5	10	0
Distillery Mixed Grains—Dried	8	6	3	8	10	0	8	6	3	8	14	0	9	0	0	9	0	0
,, Wet ...		...			..			...			..			..			...	
Brewers' Grains—																		
Dried	7	17	6		...		7	16	3	7	10	0		...		7	10	0
Wet		..		1	12	6		.		1	12	6		...		1	12	6
Distillery Malt Grains —Dried ..	7	15	0		..		8	5	0		...		9	0	0			
Wheat—																		
Middlings (Fine Thirds or Parings)	9	0	0	8	7	6	9	15	6	8	10	0	10	17	6	10	6	3
Sharps (Common Thirds	7	8	9	7	6	11	8	2	0	7	15	0	8	18	9	9	1	3
Bran (Medium) ..	6	15	0	6	7	6	7	5	6	6	18	0	8	8	9	7	13	9
,, (Broad) ...	7	0	0	7	8	9	7	12	0	7	13	0	8	13	9	8	8	9
Feeding Treacle ..	8	3	2	8	15	0	8	3	9	8	15	0	8	7	6	8	15	0
Crushed Linseed ..	24	0	0		..			...			...			...			...	
Fish Meal	18	10	0	§17	15	0	18	18	2	§17	15	0	18	3	3	§17	15	0

* F.o.r. Greenock. ** South African Yellow. † Pure China Beans. ‡ American. § White.

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